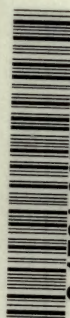


MILITARY MEDICAL MANUALS

GENERAL EDITOR:
SURGEON-GEN. SIR ALFRED KEOGH
G.C.B., M.D., F.R.C.P.


WAR OTITIS AND
WAR DEAFNESS

BOURGEOIS & SOURDILLE
EDITED BY
J. DUNDAS GRANT



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WAR OTITIS
AND WAR DEAFNESS

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WAR OTITIS AND WAR DEAFNESS

DIAGNOSIS—TREATMENT—MEDICAL
REPORTS

BY

H. BOURGEOIS AND M. SOURDILLE

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WAR OTITIS AND WAR DEAFNESS

DIAGNOSIS—TREATMENT—MEDICAL
REPORTS



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GENERAL INTRODUCTION

THE infinite variety of injuries which any war presents to the surgeon gives to military surgery a special interest and importance. The special interest and importance, in a surgical sense, of the great European War lies not so much in the fact that examples of every form of gross lesion of organs and limbs have been seen, for if we read the older writers we find little in the moderns that is new in this respect, but is to be found in the enormous mass of clinical material which has been presented to us and in the production of evidence sufficient to eliminate sources of error in determining important conclusions. For the first time also in any campaign the labours of the surgeon and the physician have had the aid of the bacteriologist, the pathologist, the physiologist and indeed of every form of scientific assistance in the solution of their respective problems. The clinician entered upon the great war armed with all the resources which the advances of fifty years had made available. If the surgical problems of modern war can be said not to differ sensibly from the campaigns of the past, the form in which they have been presented is certainly as different as are the methods of their solution. The achievements in the field of discovery of the chemist, the physicist and the biologist have given the military surgeon an advantage in diagnosis and treatment which was denied to his predecessors, and we are able to measure the effects of these advantages when we come to appraise the results which have been attained.

But although we may admit the general truth of these statements it would be wrong to assume that modern scientific knowledge was, on the outbreak of the war, immediately useful to those to whom the

wounded were to be confided. Fixed principles existed in all the sciences auxiliary to the work of the surgeon, but our scientific resources were not immediately available at the outset of the great campaign; scientific work bearing on wound problems had not been arranged in a manner adapted to the requirements, indeed the requirements were not fully foreseen; the workers in the various fields were isolated, or isolated themselves pursuing new researches rather than concentrating their powerful forces upon the one great quest.

However brilliant the triumphs of surgery may be, and that they have been of surpassing splendour no one will be found to deny, experiences of the war have already produced a mass of facts sufficient to suggest the complete remodelling of our methods of education and research.

The series of manuals, which it is my pleasant duty to introduce to English readers, consists of translations of the principal volumes of the "Horizon" Collection which has been appropriately named after the uniform of the French soldier.

The authors, who are well-known specialists in the subjects which they represent, have given a concise but eminently readable account of the recent acquisitions to the medicine and surgery of war which had hitherto been disseminated in periodical literature.

No higher praise can be given to the Editors than to say that the clearness of exposition characteristic of the French original has not been lost in the rendering into English.

MEDICAL SERIES

The medical volumes which have been translated for this series may be divided into two main groups, the first dealing with certain epidemic diseases including syphilis, which are most liable to attack soldiers, and the second with various aspects of the neurology of war. The last word on *Typhoid Fever*, hitherto "the greatest scourge of armies in time of war," as

it has been truly called, will be found in the monograph by MM. Vincent and Muratet which contains a full account of recent progress in bacteriology and epidemiology as well as the clinical features of typhoid and paratyphoid fevers. The writers combat a belief in the comparatively harmless nature of paratyphoid and state that in the present war hæmorrhage and perforation have been as frequent in paratyphoid as in typhoid fever. In their chapter on diagnosis they show that the serum test is of no value in the case of those who have undergone anti-typhoid or anti-paratyphoid vaccination and that precise information can be gained by blood cultures only. The relative advantages of a restricted and liberal diet are discussed in the chapter on treatment, which also contains a description of serum-therapy and vaccine-therapy and the general management of the patient.

Considerable space is devoted to the important question of the carrier of infection. A special chapter is devoted to the prophylaxis of typhoid fever in the army. The work concludes with a chapter on preventive inoculation in which its value is conclusively proved by the statistics of all countries in which it has been employed.

MM. Vincent and Muratet have also contributed to the series a work on *Dysentery, Cholera and Typhus* which will be of special interest to those whose duties take them to the Eastern Mediterranean or Mesopotamia. The carrier problem in relation to dysentery and cholera is fully discussed, and special stress is laid on the epidemiological importance of mild or abortive cases of these two diseases.

In their monograph on *The Abnormal Forms of Tetanus*, MM. Courtois-Suffit and Giroux treat of those varieties of the disease in which the spasm is confined to a limited group of muscles, *e. g.* those of the head, or one or more limbs, or of the abdomino-thoracic muscles. The constitutional symptoms are less severe than in the generalised form of the disease, and the prognosis is more favourable.

The volume by Dr. G. Thilbierge on *Syphilis in the Army* is intended as a *vade-mecum* for medical officers in the army.

Turning now to works of neurological interest we have two volumes dealing with lesions of the peripheral nerves by Mme. Atanassio Benisty, who has been for several years assistant to Professor Pierre Marie at La Salpêtrière. The first volume contains an account of the anatomy and physiology of the peripheral nerves, together with the symptomatology of their lesions. The second volume is devoted to the prognosis and treatment of nerve lesions.

The monograph of MM. Babinski and Froment on *Hysteria or Pithiatism and Nervous Disorders of a Reflex Character* next claims attention. In the first part the old conception of hysteria, especially as it was built up by Charcot, is set forth, and is followed by a description of the modern conception of hysteria due to Babinski, who has suggested the substitution of the term "Pithiatism," *i. e.* a state curable by persuasion, for the old name hysteria. The second part deals with nervous disorders of a reflex character, consisting of contractures or paralysis following traumatism, which are frequently found in the neurology of war, and a variety of minor symptoms, such as muscular atrophy, exaggeration of the tendon reflexes, vasomotor, thermal and secretory changes, etc. An important section discusses the future of such men, especially as regards their disposal by medical boards.

An instructive companion volume to the above is to be found in the monograph of MM. Roussy and Lhermitte, which embodies a description of the psychoneuroses met with in war, starting with elementary motor disorders and concluding with the most complex represented by pure psychoses.

SURGICAL SERIES

When the present war began, surgeons, under the influence of the immortal work of Lister, had for more than a quarter of a century concerned themselves

almost exclusively with elaborations of technique designed to shorten the time occupied in or to improve the results obtained by the many complex operations that the genius of Lister had rendered possible. The good behaviour of the wound was taken for granted whenever it was made, as it nearly always was, through unbroken skin, and hence the study of the treatment of wounds had become largely restricted to the study of the aseptic variety. Septic wounds were rarely seen, and antiseptic surgery had been almost forgotten. Very few of those who were called upon to treat the wounded in the early autumn of 1914 were familiar with the treatment of grossly septic compound fractures and wounded joints, and none had any wide experience. To these men the conditions of the wounds came as a sinister and disheartening revelation. They were suddenly confronted with a state of affairs, as far as the physical conditions in the wounds were concerned, for which it was necessary to go back a hundred years or more to find a parallel.

Hence the early period of the war was one of earnest search after the correct principles that should be applied to the removal of the unusual difficulties with which surgeons and physicians were faced. It was necessary to discover where and why the treatment that sufficed for affections among the civil population failed when it was applied to military casualties, and then to originate adequate measures for the relief of the latter. For many reasons this was a slow and laborious process, in spite of the multitude of workers and the wealth of scientific resources at their disposal. The ruthlessness of war must necessarily hamper the work of the medical scientist in almost every direction except in that of providing him with an abundance of material upon which to work. It limits the opportunity for deliberate critical observation and comparison that is so essential to the formation of an accurate estimation of values; it often compels work to be done under such high pressure and such unfavourable conditions that it becomes of little value for

educative purposes. In all the armies, and on all the fronts, the pressure caused by the unprecedented number of casualties has necessitated rapid evacuation from the front along lines of communication, often of enormous length, and this means the transfer of cases through many hands, with its consequent division of responsibility, loss of continuity of treatment, and absence of prolonged observation by any one individual.

In addition to all this, it must be remembered that in this war the early conditions at the front were so uncertain that it was impossible to establish there the completely equipped scientific institutions for the treatment of the wounded that are now available under more assured circumstances, and that progress was thereby much hampered until definitive treatment could be undertaken at the early stage that is now possible.

But order has been steadily evolved out of chaos and many things are now being done at the front that would have been deemed impossible not many months ago. As general principles of treatment are established it is found practicable to give effect to them to their full logical extent, and though there are still many obscure points to be elucidated and many methods in use that still call for improvements, it is now safe to say that the position of the art of military medicine and surgery stands upon a sound foundation, and that its future may be regarded with confidence and sanguine expectation.

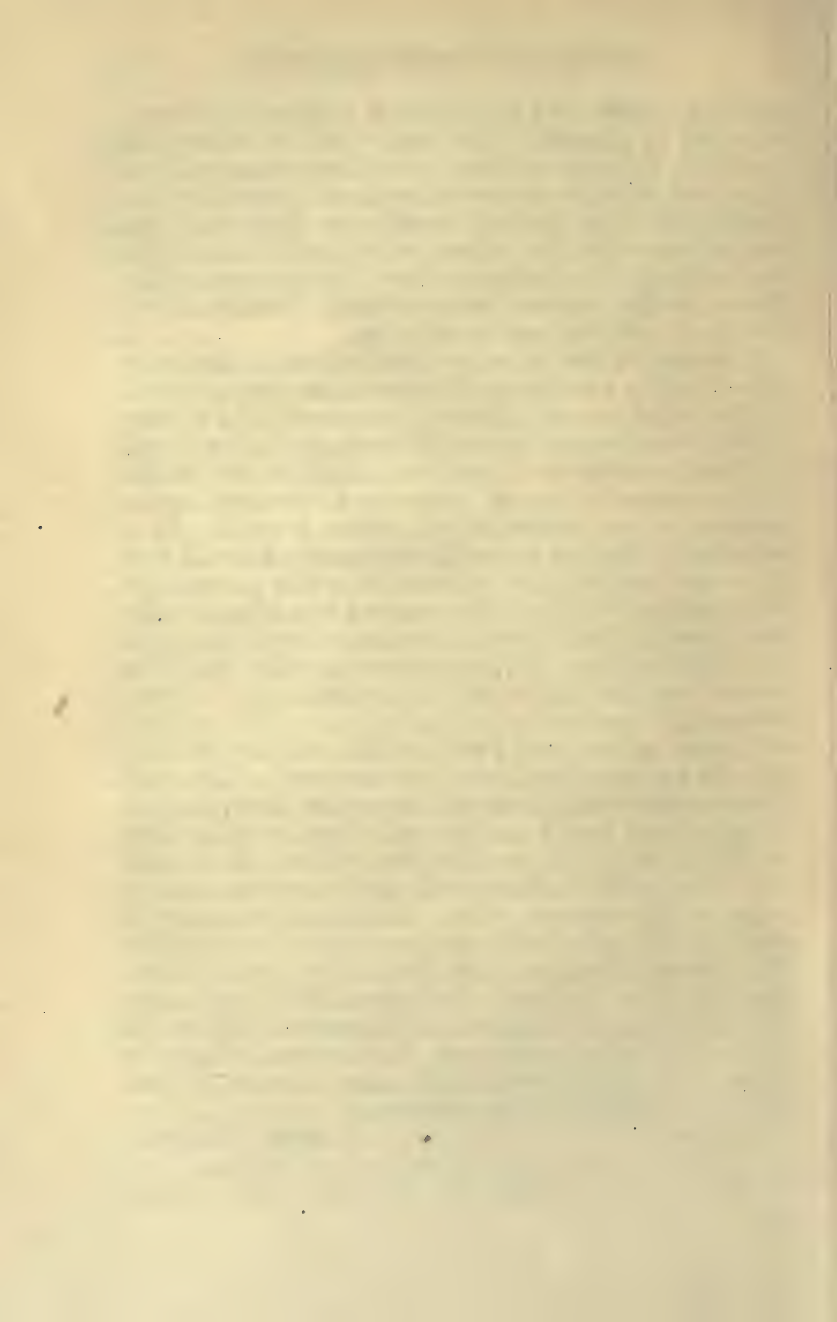
The views of great authorities who derive their knowledge from extensive first-hand practical experience gained in the field, cannot fail to serve as a most valuable asset to the less experienced, and must do much to enable them to derive the utmost value from the experience which will, in time, be theirs. The series covers the whole field of war surgery and medicine, and its predominating note is the exhaustive, practical and up-to-date manner in which it is handled. It is marked throughout not only by a

wealth of detail, but by clearness of view and logical sequence of thought. Its study will convince the reader that, great as have been the advances in all departments in the services during this war, the progress made in the medical branch may fairly challenge comparison with that in any other, and that not the least among the services rendered by our great Ally, France, to the common cause is this brilliant contribution to our professional knowledge.

A glance at the list of surgical works in the series will show how completely the ground has been covered. Appropriately enough, the series opens with the volume on *The Treatment of Infected Wounds*, by A. Carrel and G. Dehelly. This is a direct product of the war which, in the opinion of many, bids fair to become epoch-making in the treatment of septic wounds. It is peculiar to the war and derived directly from it, and the work upon which it is based is as fine an example of correlated work on the part of the chemist, the bacteriologist and the clinician as could well be wished for. This volume will show many for the first time what a precise and scientific method the "Carrel treatment" really is.

The two volumes by Prof. Leriche on *Fractures* contain the practical application of the views of the great Lyons school of surgeons with regard to the treatment of injuries of bones and joints. Supported as they are by an appeal to an abundant clinical experience, they cannot fail to interest English surgeons, and to prove of the greatest value. It is only necessary to say the *Wounds of the Abdomen* are dealt with by Dr. Abadie, *Wounds of the Vessels* by Prof. Sencert, *Wounds of the Skull and Brain* by MM. Chatelin and De Martel, and *Localisation and Extraction of Projectiles* by Prof. Ombredanné and R. Ledoux-Lebard, to prove that the subjects have been allotted to very able and experienced exponents.

ALFRED KEOGH.



EDITOR'S PREFACE

THE Editor offers this volume as a faithful rendering of the original French of Messrs. Bourgeois and Sourdille. The actual translation has been carried out by a lady who has had considerable experience in such work, and the Editor has personally checked it throughout, so that he has every confidence that very few errors can have crept in.

The work presents many features of novelty which are peculiarly appropriate to the present time. Our Allies, by their earlier active entrance into the war and the established system of compulsory service, have had longer opportunity for acquiring experience in dealing with the matters set forth in the book than we have had. The results of the longer experience are admirably presented in the work. This is more particularly obvious in the second half, where the various forms of "War Deafness" are discussed from the point of view of the recruiting, clinical and invaliding medical officer with a minuteness of detail such as we have not yet seen devoted to them. This insistence on detail in the interests of lucidity which is characteristic of French writers has been preserved by a strict adherence to the original form of phraseology, although it involves some sacrifice of English literary style. The "qualities" inherent in such a process greatly outweigh the "defects," in the opinion of the Editor, and the absolute usefulness of the information conveyed will be found to relieve this work from the necessity for any excuse for its existence. In his own official work he has found the information herein contained quite invaluable.

DUNDAS GRANT.

PREFACE

THE present war, which has brought about such great changes from the medical or surgical point of view, has shown the increasing importance of the different specialities and particularly that of otology.

On the one hand, the necessity of incorporating more and more numerous effective forces has led to a revision of the conditions of fitness for military service from the otological point of view and to the submission of difficult cases to a specialist for medical survey and report. On the other hand, a new pathology has developed and the *Otology of Warfare* contains some new chapters which were wanting in the otology of peace time.

Therefore, MM. Bourgeois and Sourdille's book appears at the right time and fills a gap. It should be read, reread and meditated on in all its parts, but certain chapters are of particularly striking interest.

Chronic otitis, a complex question, if ever there was one, when one has to do with diagnosis and treatment, is set forth in an original, vigorous and illuminating form. Labyrinthine concussion is presented in a new light, as well as the combinations of functional deafnesses. Finally, the problem of the Medical Report, the importance of which is so great from the military as well as the social point of view, is widely and clearly considered and solved; about half of the volume is reserved for it.

MM. Bourgeois and Sourdille's book is also as elegant in form as it is solid in foundation. The style is at the same time pure, clear, precise and concise; the figures are not very numerous but well

chosen, and of an eloquence which would almost permit of doing without their description.

From reading this work the impression is given that it will be useful at the same time not only to non-specialists to whom it will render otology attractive, but also to young otologists for whom it will be a perfect guide, and even to veterans of otology for whom it will represent a faultless focusing of the otology of the present day.

In wishing this elegant and reliable work a brilliant success, I am discharging a debt of gratitude to one of the authors who was a valuable collaborator with me during some difficult hours, and who, in an ambulance in the first line, knew how to show that he was at the same time a veteran specialist, a clever organiser and a good soldier.

MEDICAL INSPECTOR TOUBERT.

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WAR OTITIS AND WAR DEAFNESS

FIRST PART

NON-TRAUMATIC OTITIS

War Injuries are not the only lesions of the ear which require the Army doctor's care. The aural affections, whether old-standing or recent, which he is called upon to treat, are numerous. Some are compatible with combatant service, provided elementary precautions are taken; others call for treatment in hospital on account of their seriousness or the advantage of entrusting them to a specialist with a view to complete and speedy cure. For this reason we have devoted the first pages of this book to an account of the existing therapeutic indications for the principal aural affections.

CHAPTER I

EXTERNAL OTITIS

FURUNCLE

Diagnosis.—A furuncle is always situated in the external cartilaginous portion of the auditory meatus. It is visible without the use of special instruments.

It is very painful, and the intensity of the pain may lead to the illusion that the affection is of a serious nature; the insomnia, the starvation consequent upon the suffering accompanying mastication, and moderate pyrexia, alter the expression of the face to a certain extent, and favour the false impression.

A diagnosis can be arrived at after a careful examination.

Furuncles may be small and superficial, or deep-seated, the latter attaining to a considerable size.

The former present the appearance, when the auricle is pulled upwards and backwards, of pointed swellings, which, when mature, are yellowish at their summit.

The deep-seated ones appear as rounded projections, wide at their base, which more or less occlude the lumen of the meatus; they develop into sub-cutaneous abscesses; they become complicated by infiltration of the cellular tissue round the auricle. In the case of anterior furuncles, there would be œdema and redness of the tragus, lymphangitis and adenitis in front of the tragus; in the case of the posterior ones, œdema, redness, lymphangitis and adenitis in the mastoid region; in the inferior ones, parotid adenitis; in the superior, infiltration of the sub-cutaneous cellular tissue of the temporal region.

This outward extension, and particularly the swelling behind the auricle, which resembles at first sight that of mastoiditis, may lead us into error. An important sign distinguishing a furuncle is the character of the induced pain. The pain is, in fact, increased by any attempt to manipulate the meatus. If the furuncle is anterior, mastication is impossible and pressure on the tragus is unbearable; in the

case of a superior furuncle traction of the auricle upwards is painful; traction backwards in the posterior; pressure underneath and elevation of the meatus, in the inferior.

This peculiar characteristic of the induced pain renders it possible for the non-specialist to attribute the otalgia from a furuncle to its proper cause. The diagnosis is in reality only doubtful when it lies between certain posterior furuncles and mastoiditis, especially when there is at the same time suppuration in the middle ear. We have attempted to put together the chief points in the table on pages 4 and 5.

Treatment.—It will be found sufficient to treat simple cases by the application of moist dressings over the region of the ear, and the instillation of soothing antiseptic drops, such as:—

Van Swieten's Liquor (Liq. Hydrarg. Perchlor.)
Neutral Glycerine, of each 20 grammes

OR

Carbolic Acid Crystals	1 gramme
Neutral Glycerine	40 grammes

This method sometimes has the inconvenient result of causing maceration of the skin and of exposing it to successive inoculations.

Recurring furuncles, as well as the deep-seated ones which are characterised by lengthy development and puffiness of the regions round about the auricle, require surgical treatment at the hands of a specialist. This treatment consists of an incision at the moment of maturation; an opening made too early is useless and may be even harmful. This little operation causes intense pain, and it is advisable to anæsthetise the patient by means of the inhalation of a few whiffs

	<i>Furuncle.</i>	<i>Acute median otitis.</i>	<i>Acute median otitis (complicated by mastoiditis).</i>	<i>Acute or chronic suppurative median otitis (complicated by furuncle).</i>
<i>Previous history</i>	Furunculosis. Dry eczema with pruritus and abrasion.	Naso-pharyngeal infection.	Naso-pharyngeal infection followed by acute median otitis.	More or less old - standing otorrhea with dermatitis.
<i>Onset. Course</i>	Sudden. Course—in successive attacks.	Onset, more or less sudden. Course progressive. Relief from pain on commencement of discharge.	Onset gradual. Course progressive.	As in simple furuncle.
<i>Hearing-power</i>	Normal, except if the meatus is occluded.	Greatly diminished.	Greatly diminished.	More or less diminished.
<i>Discharge</i>	Slight. Thick from the first.	Profuse. Sero-purulent, then purulent.	Sometimes very profuse; sometimes slight; always purulent.	Variable in quantity.
<i>Peri-auricular swelling</i>	Variable according to situation of furuncle. When behind, simulates mastoiditis.	None.	If mastoiditis extending outwards, retroauricular swelling with displacement of auricle.	As in simple furuncle.

<i>Induced pain</i>	By manipulation of meatus. When there is mastoid lymphangitis, pressure on cedematous zone is painful; the neighbouring bone is not tender and manipulation of meatus is always more painful than pressure on mastoid region.	By pressure on tragus and antrum.	By pressure on the whole of the mastoid process, on the tip and posterior edge, outside the cedematous zone. Manipulation of the auricle is painless.	As in simple furuncle.
<i>Otoscopic examination</i>	Swelling of the external part of the auditory meatus.	Meatus clear; tympanic membrane red and bulging, subsequently perforated.	Mastoiditis may extend to the meatus with formation of a fistula, but this fistula is accompanied by swelling or sagging of the postero-superior wall of the deep bony part of the meatus. The bone can be felt with a probe. The cartilaginous meatus is normal.	There are simultaneous lesions of the external auditory meatus, the tympanic membrane and the cavity of the tympanum.

of chloride of ethyl. The incision is carried out by means of a furunculotome, or better still by the use of the galvano-cautery. It is followed by expression, then by frequently repeated dressings with small strips of gauze moistened with alcohol or Alibour water,¹ and over the dressing a square of absorbent cotton wool and a bandage. At each dressing the part should be carefully dried, as it is important to avoid maceration of the integuments.

Furuncles sometimes recur in a disheartening manner; for such cases, in time of peace, we resort to auto-vaccines according to Mauté's method.

ACUTE DIFFUSE EXTERNAL OTITIS

Diffuse external otitis is an inflammation of the cutaneous lining of the external meatus in general, spreading even to the tympanic membrane. It may follow a local inoculation or suppuration of the middle ear. In otorrhœa the skin of the external meatus becomes infected all the more readily as the repeated use of irritant antiseptics favours the penetration and development of pathogenic germs.

The clinical picture of diffuse external otitis is the same as that of furunculous otitis, but it is more exaggerated; the pain in the ear is extremely violent during mastication, which is thus rendered impossible; the slightest pressure on the tragus, the auricle, the parotid and mastoid regions gives rise to intense pain.

The meatus is completely occluded by the swelling of the infiltrated skin, which is red and covered with pus.

¹ Copper Sulphate, $2\frac{1}{2}$ drachms; Zinc Sulphate, 9 drachms; Camphor, 1 drachm; Powdered Saffron, $\frac{1}{2}$ drachm; Water, 40 ounces.

The œdema, the lymphangitis and the adenitis give rise to considerable swelling round the ear. High temperature is persistent and may reach 38.5° to 39° C. (101.3 – 102.2° F.).

The **diagnosis** of diffuse external otitis rests upon the intensity of the symptoms, the character of the pain peculiar to lesions of the meatus, and the spreading of the inflammation over the whole of the cutaneous lining of the meatus.

The difficulty is to locate the origin of the dermatitis. At the outset this cannot be determined. As with furunculous otitis, the acute symptoms must first be alleviated in order that a view of the meatus may be obtained; when it is possible to introduce a speculum the existence of a previous furunculosis or of median otitis will often be recognised.

For **treatment**, admission into a field ambulance or a special hospital is necessary. All traumatism or irritation of the integuments of the meatus must be avoided.

At first, warm moist dressings and general analgesics are employed.

After forty-eight hours of treatment a small speculum can usually be introduced. By means of Hartmann's small cannula syringing with tepid boiled water or a slightly alkaline solution is carried out; the deeper part of the meatus is thus cleared of desquamative epithelial débris which have accumulated there. Acute or chronic median otitis may or may not be present. Careful drying should be carried out and the walls of the meatus plastered with a thin layer of oily cream containing oxide of zinc.¹ A dry aseptic strip of gauze is introduced reaching to

¹ See page 10.

the tympanic membrane; this absorbs the pus as fast as it is formed. The dressing should be renewed once or oftener in twenty-four hours according to the case.

In cases infected with the *Bacillus Pyocyaneus*, the use of Peru balsam is recommended. After cleansing and drying, five or six drops of the pure balsam should be poured into the meatus: this treatment should be continued for six or seven days.

INDUCED EXTERNAL OTITIS

Some cases of external otitis take an abnormally long time to cure, and the symptoms return more markedly when discharge from hospital is imminent. One of the authors has seen a case of external otitis with an unusually profuse suppuration in an individual convicted of inducing conjunctivitis with ipecacuanha powder; the agent employed to cause the otitis was not discovered.

Treatment.—As soon as possible, isolation, forbidding of outings on account of the frequent dressings, strictly low diet.

The dressing should be carried out by the doctor or under his supervision; it should be thick and impervious; an endeavour should be made to find out if the patient displaces it between the sittings. The patient should be discharged from hospital without convalescent leave; on his case-paper should be written: "Simple external otitis subject to recurrences; no middle ear suppuration; no possibility of complications in the ordinary course of events, and quite compatible with combatant service."

This method has been found sufficiently prophylactic.

CHRONIC ECZEMA

Eczema of the external meatus is of frequent occurrence; it is not serious but often fairly annoying.

It may occur as a primary condition, but sometimes arises from local irritation caused by the contact of the pus from chronic suppurative median otitis.

The patient always complains of the same symptom: *violent itching at night-time*; he scratches the part and rubs the skin off; in this way furuncles frequently have their origin.

The auricle and meatus are generally affected at the same time.

In simple cases the skin is dry, cracked and scaly. The scales may be mixed with cerumen or with pus from the tympanum, forming hard plugs which cause deafness; the extraction of these by means of syringing restores the hearing.

Under the influence of certain conditions—errors of diet, neglect of cleanliness of the part—the chronic eczema is complicated by acute attacks; the skin becomes red, swollen and the purulent oozing is extremely abundant.

The *treatment* of the dry chronic form consists in clearing away the epidermised débris by one or two swabbings with nitrate of silver, 1–20. Cure may follow immediately; if not, one of the classic ointments containing tar or ichthyol may be used, such as :—

Washed crude tar	..	..	..	..	1 gramme
Ichthyol	2 grammes
Lanoline	} aa 6 grammes
Oxide of zinc	
Vaseline	
					4 grammes

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or

Ichthyol	1½ grammes
Salicylic acid	½ gramme
Oxide of zinc	2 grammes
Lanoline	5 grammes
Vaseline	10 grammes

The patient should be warned against all irrigation with antiseptic lotions or even with simple water. Water does not agree with such ears as these ; their toilet must be carried out by the use of liquid vaseline or very warm alkaline lotions, followed by careful but non-irritating drying.

The acute attacks call for rigid vegetarian diet, and syringing out of the meatus, under the guidance of the forehead mirror, by means of Hartmann's cannula, with a solution of nitrate of silver (1 in 2,000), bicarbonate of soda (15 per 1,000) or chamomile water. Subsequently, dressings moistened with chamomile water may be used after the application to the meatus of an ointment containing oxide of zinc, such as :—

Oxide of zinc	..	..	..	2 grammes
Glycerole of starch	..	..	..	} aa 5 grammes
Lanoline	..	..	..
Vaseline	..			

Orange flower water added drop by drop, until the consistency of an oily cream is reached.

The introduction of ointments of dense consistency or in large quantity into the auditory meatus should be avoided, as the cleansing would become extremely difficult.

CHAPTER II

ACUTE SUPPURATIVE MEDIAN OTITIS

A complete study of acute median otitis naturally does not enter into the plan of this work. We desire merely to recall for the non-specialist the therapeutic indications.

There is one which comes before all others, namely, that for early paracentesis. An otitis which has been allowed to rupture spontaneously runs a great risk of never healing and of developing into a chronic otorrhœa; ¹ this passage into chronicity must be avoided at any price.

Therefore, any soldier who is suspected of being the subject of acute otitis should be referred to a neighbouring specialist, without waiting for the appearance of a discharge; this is the best means of preserving efficiency; he can be sent back to his regiment immediately if it is found to be a case of simple otalgia; and, judiciously treated, can be rapidly and completely cured should the case be one of genuine otitis.

The doctor should suspect acute median otitis when he finds the three following symptoms occurring together: otalgia, pyrexia and deafness.

¹ See *Progrès Médical*, 1917, No. 11, *Pourquoi une otite moyenne aiguë devient-elle chronique?* By H. Bourgeois.

The pain of the otitis is very severe, progressively increasing and pulsatile ; it is aggravated by pressure on the tragus (the pressure being transmitted to the tympanic membrane) and over the antrum ¹ and the tip of the mastoid process ; the otalgia from a furuncle is aggravated by manipulation of the meatus ; reflex otalgias are unaffected by any of these procedures ; the discomfort of temporo-maxillary arthritis is revealed by palpation of the joint and by lateral movements of the maxilla. Pyrexia is always present when suppuration comes on.

The deafness points to a deep-seated aural cause for the otalgia ; there is no median otitis without marked deafness.

Thus there is no need for the forehead mirror or the speculum in order to diagnose a case of otitis and to send the patient to a specialist.

The latter will realise the indications for paracentesis ; we need not remind him of them, or of the technique.

We will, however, take the opportunity of pointing out our preference for general anæsthesia under chloride of ethyl to the local deadening of sensibility by means of Bonain's solution. The former is quicker, more convenient, more certain, and prevents all useless traumatism of the tympanic membrane.

After paracentesis, we prefer dry aseptic dressings, according to the well-known technique ; every case of otitis is in the first place monomicrobial ; Lermoyez has shown, by statistics, that by avoiding secondary

¹ The participation of the mucous membrane of the antrum in the inflammatory process is nearly always a phenomenon of acute otitis. Mastoiditis only exists when there is mastoid osteitis. The pain when it first occurs must be due to a slight periostitis accompanying the antritis.

infection patients are cured in the minimum amount of time.

We reserve antiseptic irrigations for profuse purulent discharges, which only manifest themselves after several days, and for those cases where dry aseptic dressings are not available.

The advantages of this early paracentesis must be insisted on: the infection has had no time to spread, the membrane is incised at a spot favourable for evacuation of the pus, the wound is linear, and it cicatrises easily without deterioration in the texture of the tympanic membrane. If we wait for spontaneous rupture mastoid and endo-cranial complications are more liable to occur; the opening is not always situated at the most dependent point; hence putrefaction, retention, chronicity; the perforation may be too small and the drainage of the tympanum unsatisfactory; it may be too large and regeneration will be impossible or defective, for a perforation occurring spontaneously would not be linear; it is due to loss of substance from necrosis of the tissues; it will not close, or if it does so, it will be by the formation of an atrophic cicatricial area, devoid of the normal elasticity of the tympanic membrane.

An otitis properly treated will generally cease in two or three weeks. A purulent discharge which has no tendency to disappear at the end of a month, should direct attention to the naso-pharynx and the mastoid region. In the naso-pharynx adenoids, a persistent focus of infection, should be sought for and, if present, treated; the possibility of a latent osteitis in the mastoid process must be kept in mind; this would be indicated only by a slight evening rise of temperature and a minimal tenderness on pressure;

14 WAR OTITIS AND WAR DEAFNESS

- opening of the mastoid cells is then urgently called for.

Should a case of otitis, in which suppuration has already become established, come before the doctor, he should all the same refer it to a specialist, so that the latter may apply clean dressings, supervise the drainage and assure cure in the shortest time.

CHAPTER III

CHRONIC SUPPURATIVE MEDIAN OTITIS

The number of soldiers suffering from otorrhœa is considerable; we should like to remind medical officers of regiments and ambulances of the signs which indicate the necessity for sending such patients to the specialist, and for the latter we shall point out certain diagnostic considerations and certain therapeutic indications; in particular, the elements of an operative technique, still little known, which has recently formed the subject of a work by one of us (Sourdille) and which is of interest at the present time.

Diagnosis of chronic otitis in general.—There are three symptoms which lead the patient to consult the doctor, viz. the otorrhœa, the deafness and the pain.

The suppuration is the fundamental symptom; it is very variable in quantity, influenced by nasopharyngeal inflammatory attacks and the absence of local hygiene. The quantity is by no means in proportion to the seriousness; certain scarcely perceptible discharges are more dangerous than others which are profuse. Fetor and the presence of blood call for transference of the patient to a specialist.

Old-standing deafness in addition to a discharge of pus in the meatus, bears witness to a lesion of the middle ear; it must, however, be remembered that simple external otitis with obstruction of the meatus has this syndrome temporarily.

The pain is not the sharp suffering of a furuncle or of an acute otitis; it takes the form of a sensation of heaviness in the region of the ear, of hemicrania, of pseudo-migrainous crises; it draws attention to possible complications and justifies transference to a specialist who will determine its reality and its significance.

Finally, if on brief otoscopic examination, after cleansing the auditory meatus, a perforation of the membrane is discovered, it points to the origin of the suppuration being in the tympanum. To try to carry out this cleansing by the dry method is to lose time and to cause the patient useless suffering; the meatus should first be washed out with a pear-shaped ear syringe or a douche, then with Hartmann's cannula, using Labarraque's Solution diluted with warm boiled water; then dried, and the tympanic membrane wiped with a fine wool-holder coated with cotton-wool moistened with liquid vaseline. A clear view of the perforation will generally be obtained. Some cases, however, present special difficulty.

Extensive destruction of the membrane with absence of the malleus may lead to the inner wall of the tympanum being mistaken for the membrane; on touching this promontory gently with a probe it is found to be hard and resistant; if the probe is bent before being introduced, its bent end may be passed upwards and backwards internal to the tympanic

ring, and it comes against a bony ridge when it is pulled outwards towards the observer.

A perforation, the edges of which are stuck to the inner wall, is imperceptible at the first glance; this is especially the case with regard to many perforations in the postero-superior quadrant, the inferior edge of which adheres to the promontory; a bent probe again averts any mistake; if, on trying to direct it towards the aditus, its course is impeded, there exists simple retraction of the membrane; if it penetrates, there is loss of substance.

A small perforation covered by a crust may escape notice, especially when at the level of Shrapnell's membrane; we must not feel satisfied until the whole of the deep part of the meatus has been thoroughly cleansed with liquid vaseline.

The perforation may be completely filled up by a fleshy granulation, and the lumen of the meatus may even be occluded by a large polypus, the surface of which has the appearance of epidermis; a probe will go round this granulation or polypus, and it will often cause it to bleed.

The existence of a tympanic perforation must not be denied on account of an absence of the "Valsalva" perforation sound, the orifice of the tube may be closed by the sticking together of its walls; tympanic adhesions may prevent the air from penetrating into the meatus.

To sum up, it is easy to diagnose chronic otitis; thorough cleansing and a good light will show the tympanic membrane to be whole if the suppuration is coming merely from the integuments of the meatus.

So as to omit nothing, we will mention a mastoid fistula opening into the meatus, and of which we

have already enumerated the principal characteristics when dealing with the subject of furuncle. Such a mastoid fistula with, at the same time, an intact tympanic membrane, is a rare variety of acute mastoiditis. It calls for immediate opening of the mastoid process. If the fistula occurs simultaneously with chronic otitis its presence indicates chronic mastoiditis and demands radical operation and opening up of the petro-mastoid region.

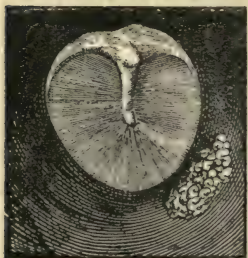


FIG. 1.—Fistula of the posterior wall of the meatus, and the granulations covering it.

Diagnosis of the different varieties according to their localisation.—

The middle ear is an eminently complex cavity, having distinct parts; the course and the treatment of an aural suppuration vary entirely according to the region of the tympanum in which it has its origin. These different types of otitis classified according to the

localisation, correspond fairly well to the different varieties of perforations of the tympanic membrane.

Tubo-tympanic suppuration.—*Anterior and inferior perforations.*—The anterior part of the tympanum, which is close to the tubal orifice and the last part of the Eustachian tube, contains a number of mucous glands, the culs-de-sac of which are liable to become the seat of a chronic infection; the latter is kept up or awakened by pathological changes in the nasopharynx, which are injurious both from their own chronic or recurring infectivity and from the state of congestion which they keep up; adenoid vegetations and enlarged posterior extremities of the turbinals,

etc., come foremost in causing this. Many patients, especially young children, literally "blow their noses" into their ears.

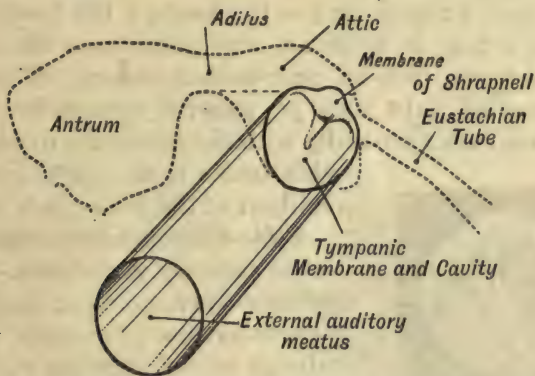


FIG. 2.—Scheme of the three storeys of the middle ear and of the portion directly visible on otoscopic examination.

The perforation may be antero-inferior, inferior or at the same time antero-inferior and postero-inferior; in the last case the perforation is reniform

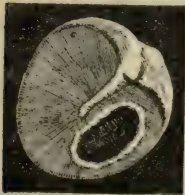


FIG. 3.—Antero-inferior perforation of tympanic membrane.



FIG. 4.—Reniform perforation of tympanic membrane.

in appearance, the depression corresponding to the handle of the malleus.

It is more often antero-inferior, opposite the orifice

of the Eustachian tube. The discharge, rather mucous than purulent, is driven from the Eustachian tube by each effort of "Valsalva." The membrane is normal, or more or less thickened; the lower part of the drum is vascular, and sometimes there are granulations, but no deep-seated lesions. There is absence of pain and of general symptoms. The deafness varies generally with the amount of discharge,

which in its turn depends on the condition of the naso-pharynx.

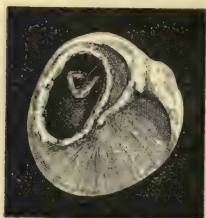


FIG. 5.—Postero-superior tympanic perforation.

Through the perforation can be seen the descending branch of the incus and its articulation with the stapes.

Attico-tympanic suppuration.—*Postero-superior perforation.*—The anatomical arrangement (see Plate I) explains how precarious is the drainage of an attic suppuration by way of the tympanum; the two cavities communicate with each other by a narrow cleft, a real attico-tympanic isthmus, bounded on the inside by the inner wall of the tympanum and on the outside by the body of the incus and the head of the malleus.

The slightest congestive swelling of the mucous membrane produces stagnation of the pus and secondarily ulceration, osteitis, chronicity. The perforation occupies the postero-superior quadrant or the whole of the posterior segment. The pus is inspissated and fetid. There are often granulations or polypi; multiple, sessile and small granulations bear witness to ulceration of the mucous membrane and to a superficial osteitis arising from the stagnation of the pus from above; polypi obtrude themselves at the level of the posterior edge of the tympanic

Plate I



View of the postero-superior aspect of the ear after ablation of the tegmen tympani et antri.

A. Antrum.
Ad. Aditus.
En. Body of the incus.
e. Its descending process.
e'. Its horizontal process.
P.l.e. Lateral fold of the incus.

M. Head of the malleus.
T.m. Tendon of the tensor tympani.
r. Its mucous covering.
Et. Stapes.
Is. Attico-tympanic isthmus.

[To face p. 20.]

Plate II



Suppuration in the attic.

It is to be noted that the bony septum is fixed against the inner wall of the attic. The attico-tympanic isthmus has disappeared; the external attic is much increased in size.

- | | |
|--|--|
| <i>M.</i> Head of the malleus. | <i>Att. ext.</i> External attic. |
| <i>En.</i> Partly necrosed incus. | <i>Ad.</i> Aditus. |
| <i>P.m.l.</i> Perforation of Shrapnell's membrane and necrosis of wall of attic. | <i>A.</i> Antrum full of cholesteatomatous débris. |

ring, most often arising from the region of the aditus and the incus. Treatment confined to the accessible visible lesions is not sufficient to dry up the otorrhœa, the lesions at the deeper part of the tympanum may be cicatrised and pus can be seen still oozing out from the attic or the antrum; in order to verify this, the perforation should be plugged with a little strip of gauze, the upper surface alone of which is found to be stained with pus next day.

The presence of attico-tympanic suppuration indicates the possibility of the risks of retention; a large polypus, or a plug of dried pus, may be the cause of such retention which manifests itself by headache, tinnitus, vertigo; the prognosis is more uncertain than in the preceding condition, and all the more uncertain as the suppuration very often reaches the mastoid antrum.

Tympanic suppuration. — Central perforation. — Complete loss of tympanic membrane.—A like purulent discharge may indicate the direct continuation of an acute otitis which has been neglected. The acute affection may have been virulent and have produced great destruction at the time; but more often an infection which, on the contrary, is sluggish when left to itself, has brought about necrosis of a considerable portion of the membrane; such is the origin of very many of the otorrhœas of childhood; finally, the membrane is, sometimes, of such a fragile texture that it is seen to melt, as it were, under the action of slight disease.

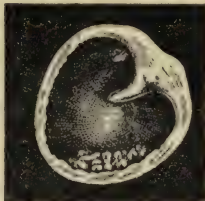


FIG. 6.—Complete loss of tympanic membrane.

Extensive destruction of the tympanic membrane with granulations on the floor of the drum.

Such a perforation may indicate either a simple suppuration in the large cavity of the middle ear, kept up by faulty hygiene or defective treatment, or more complicated lesions in which the adjacent cavities participate ; the diagnosis will be established by degrees according to the result of rational treatment.

Suppuration in the attic and attico-antral suppuration.—Perforation of Shrapnell's Membrane.—A perforation of Shrapnell's membrane bears witness to a suppuration in the attic, to which the pathological structure gives a particular appearance. Plate II presents a view of the attico-antral region, and it shows some important lesions in the antrum, the aditus and the external attic ; there is osteitis on the inner surface of the wall of the attic and the outer surface of the incus and of the malleus ; further, the relation of the two attics is reversed ; the osseous septum formed by the body of the incus and the head of the malleus is adherent to the inner wall of the tympanum. In this way the *internal attic has disappeared, as well as the attico-tympanic isthmus ; there is no further communication between the upper storey and the tympanum ;* the pus pours directly into the external auditory meatus (Plate II).

The perforation is situated directly above the short process of the malleus ; it is occasionally covered by a crust of dried pus. The loss of substance often encroaches on the osseous framework and thus becomes much larger than the membrana flaccida itself. A small polypus is often present. Inflation by Valsalva does not pass through. Suction with Siegel's speculum sometimes draws out a drop of pus. Prognosis is uncertain on account of involvement of the antrum,

the close proximity of the meninges, defective drainage, and the impossibility of approaching the lesions by the natural routes.

Diagnosis according to the stage and extent of the lesions.—*Lesions of the mucous membrane.*—In the first stage of chronic otitis the mucous membrane is thickened, with some oozing; at a later stage it ulcerates; it then bleeds at some point and is more or less granular; when a granulation enlarges and becomes pedunculated, it is called a polypus.

Osteitis.—The mucous membrane does not long remain ulcerated without the subjacent bone becoming infected. Superficial osteitis shows itself by fleshy granulations; the recognised sensation of bare bone can be felt by the probe, a very painful exploration, often useless for diagnostic purposes.

Granulations and polypi.—An osteitis which has extended to a slight extent, becomes a “bed” of red, sessile and bleeding granulations. If it is limited to one point, the fleshy granulation, under the action of gravity, develops into a polypus inserted by its superior pole; it is sometimes very large. There are, therefore, two kinds of polypi, those which reveal a simple local œdematous degeneration confined to the mucous membrane, and those which bear witness to osteitis; the latter are the more numerous. When the osteitis remains superficial, it preserves this aspect of a bare sprouting surface; when the infection reaches the deeper part of the bone, the latter becomes necrosed and has the appearance of an absolutely bared region, like ivory.

Cholesteatoma.—An account of the last kind of lesion is of considerable importance; it is that of cholesteatoma, which is the name given to the result

of an epidermic proliferation taking the form of clumps or small collections of scales, with a "mother-of-pearl" appearance; they are met with almost exclusively in attico-tympanic and attico-antral suppurations. The epidermis of the meatus, passing through the perforation, invades the suppurating cavity and covers the ulcerated surface; instead of being thrown off in the normal manner, it proliferates abundantly and desquamates continually under the form of scales which adhere together. When masses, thus formed, can find no outlet for extrusion by way of the meatus, they increase where they are, producing around them a rarefying osteitis; meninges, membranous labyrinth, and facial nerve become in this manner exposed, and all the complications of otitis may follow.

Accessible lesions.—Tympanic and tubo-tympanic suppurations are accessible to our means of investigation; they only present, in general, changes in the mucous membrane or superficial lesions of the bone.

Inaccessible lesions.—Attico-tympanic suppurations reveal to us, through the posterior or the postero-inferior perforation, osteitis of the floor, that of the posterior framework (bony casing) of the facial nerve, and granulations indicating osteitis of the long process of the incus; the incus may be eliminated; though not perceptible, suppuration in the attic, the aditus, and the mastoid antrum, must be suspected; cholesteatomatous material should be searched for in the water used for syringing.

Perforation of Shrapnell's membrane and lesions of the ossicles.—Perforations in Shrapnell's membrane show us only the exposed malleus, but we know that lesions of the external attic, the aditus and the mastoid antrum are the rule; otoscopic examination does not

reveal this deep-seated extension of lesions which alone could account for the abundance of the discharge; but, on the other hand, it furnishes us with some important data as to the state of preservation of the ossicles and the continuity of the chain—a very important point in the functional prognosis and the indication for operation.

The lesions of the ossicles are habitually proportional



FIG. 7.—Perforation in Shrapnell's membrane.

to those of the walls of the attic at their level.

Four types of case may present themselves:—

(a) *Perforation limited to Shrapnell's membrane.*—The ossicles may be affected with osteitis, but the lesion is superficial and the continuity of the chain is not broken.

(b) *Perforation of Shrapnell's membrane with osteitis and elimination of the anterior half of the wall of the attic.*—The head of the malleus is alone necrosed and more or less diminished in size; the chain of ossicles is still continuous.



FIG. 8.—Perforation of Shrapnell's membrane with disappearance of the anterior part of the wall of the attic.

The malleus is in its place. The suppuration has yielded to medical treatment. Hearing for low voice at 9 metres.

(c) *Perforation of Shrapnell's membrane with total elimination of the wall of the attic*, that is to say, *spontaneous total atticotomy*.—The head of the malleus, the body and the horizontal process of the incus have all disappeared. The chain is broken. Deafness has become marked and irreparable.

(d) *Disappearance of the incus*, that is to say, of the bony septum which protects the tympanum; this is often followed by invasion of the latter with suppuration, unless the tympanic membrane is completely adherent to the promontory; but in this case the osteitis extends along the descending process of the incus, reaches the drum and causes a *postero-superior perforation* in addition to the perforation in Shrapnell's membrane.

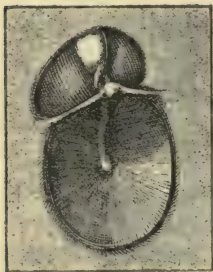


FIG. 9.—Perforation of Shrapnell's membrane and complete disappearance of the wall of the attic.

Complete spontaneous atticotomy. The incus has disappeared; hearing for low voice at 1 m. 50.

Chronic mastoiditis.—Suppuration in the attic revealed by a posterior perforation or by a perforation of Shrapnell's membrane is nearly always complicated by suppuration in the mastoid antrum; we have no means of determining the development of

these lesions; only the profuseness of the discharge and the persistence of its fetidity, in spite of treatment, lead to our recognising it. It is in this that the danger of the otorrhœa lies.

Diagnosis of the severity.—We have not sufficient space to study the prognosis and complications of chronic otitis. We must content ourselves with enumerating the *symptoms of danger*, which

demand a thorough examination and often an immediate operation.

Headache disappears after cleansing or removal of a polypus when it is a symptom of a passing retention. Persistent headache must be very seriously considered.

Rise of temperature is a symptom of acute extension of the infection ; operation is called for.

Emaciation and asthenia are often indications of extension to the brain.

Paresis and paralysis of the facial nerve call equally for operation.

Vertigo signifies irritation or invasion of the labyrinth ; polypi situated at the level of the fenestra ovalis are sufficient to produce this symptom ; erosion of the osseous labyrinth is shown by the fistula sign—*i.e.* nystagmus induced by compression of air in the auditory meatus ; suppuration in the membranous labyrinth is indicated first by diminution and then by abolition of the caloric and rotatory reflexes. The hearing-tests reveal equally well that there is invasion of the internal ear, by rapid increase of the deafness, lateralisation of Weber to the good side and diminution of bone-conduction.

Differential diagnosis from tuberculous otitis.
—Tuberculosis of the middle ear occurs almost exclusively in the subjects of established phthisis ; it is rare, one case in two thousand being found by Sourdille in a “centre” set apart for the isolation of consumptives.

It is characterised by its indolence, the multiplicity of the perforations,¹ the profuseness of the suppuration, the extensive progress of the lesions with rapid

¹ For further details see Bourgeois, in *Précis de Pathologie Chirurgicale*, Vol. II. Masson et Cie., éditeurs.

invasion of the Fallopian Canal and the internal ear.

Therapeutic indications. — Treatment of the severe forms. — Patients who present any of the dangerous symptoms enumerated above, and particularly signs of endocranial complication, must be operated on immediately; opening up of the petromastoid region is the minimum that should be done for them.

Treatment of the simple forms. — Tubo-tympanic and simple tympanic suppurations, with a large perforation, admit of a favourable prognosis; they should not interfere with military service any more than they stand in the way of the occupations of civil life. We have, however, to intervene for the purpose either of instituting a *rapidly* curative treatment, of alleviating a temporarily aggravated condition or of advising with regard to aural hygiene.

Curative treatment. — Suppuration is often kept up either by the condition of the naso-pharynx or faulty treatment.

It is frequently sufficient to operate on adenoid vegetations and posterior extremities of the turbinals, and to disinfect the nasopharynx, in order to cause the otorrhœa to dry up in a few days.

The stopping of all introduction of water in the course of the toilet, of all irrigation or so-called antiseptic instillations, will have the same satisfactory result, provided preliminary disinfection is carried out followed by the application of a dry antiseptic dressing.

These simple means may be insufficient; perhaps there are granulations to cauterise or a polypus to remove, but in this case also the cure is rapid.

At other times diffuse lesions of the mucous membrane demand special treatment; aural baths of nitrate of silver (1 in 40), instillations of boricated alcohol, insufflation of boracic acid powder, or applications of a solution of chloride of zinc, there being so many means that choice must be made according to the particular case.

Palliative treatment.—After such treatment, the otitis either dries up or it merely diminishes in quantity; treatment in hospital should not continue indefinitely; it should even be of very short duration; the patient should be sent back to his regiment, taking with him the otological slip shown at the end of this volume, on which are mentioned the exact diagnosis and appropriate treatment, such as cleansing of the meatus by the dry method, followed by a bath of peroxide of hydrogen or the instillation of boricated alcohol.

Treatment of cases with a tendency to become worse.—The prognosis in attico-tympanic and atticoantral suppurations must be reserved. If certain very mild and subsiding cases appear to be suitable for **combatant service**, other more serious ones, involving total incapacity, call for almost perpetual hospital treatment and are eligible for **discharge** in conformity with ministerial regulations.

Many of these patients go to make up the valuable “auxiliary” forces, where supervision and occasional palliative treatment can be carried out.

Finally, it is advisable to cure these patients surgically and to render them **fit for combatant service**. But they cannot all be operated on. Curative surgical treatment must be reserved for those whose moral and physical value renders them capable

of making good soldiers. The functional point of view must also be kept in mind and the question asked as to whether the hearing of the operated ear will be sufficient after the suppuration has been cured.

We propose considering the palliative and the curative treatment.

Palliative treatment. — *Fleshy granulations.* — Chemical cauterisation of the limited lesion is the best treatment, and chromic acid is the best caustic ; but it dissolves and must be handled with precaution, either in the form of a very small crystal or deliquesced at the end of a blunt probe, or in a concentrated solution on a fine wool-holder. The field of operation should be previously cleansed by syringing with Hartmann's cannula and carefully dried. Another syringing will remove any excess of chromic acid if this is thought necessary in order to prevent secondary painful phenomena.

For granulations which bleed only very slightly a solution of chloride of zinc (1 in 10) or a solution of equal parts of formol, alcohol and glycerine may be used ; the latter is fairly efficacious but causes pain.

Large fleshy granulations offer resistance to the caustics ; they can be curetted, but this curetting is an operation which requires great precautions of antisepsis in the first place, and of asepsis, in order not to bring about complications ; Luc has, for some time, pointed out the danger of incomplete operations in an infected area ; besides, this curetting by the natural routes is always an incomplete operation, for large and recurrent multiple granulations are always symptomatic of a suppuration which has extended beyond the accessible zones. Accordingly, for these patients we prefer to advise discharge or opening

up of the petro-mastoid region, according to the causes.

Polypi.—Local anæsthesia, removal with a snare worked by a lever or with a curette embracing its pedicle, and at the same time applications of a solution of chloride of zinc to the subjacent zone of osteitis, are indicated.

Cholesteatoma.—A limited lesion close to the aditus, giving rise to an almost insignificant amount of suppuration and to the production of small cholesteatomatous masses which are ejected through a sufficiently large perforation of the posterior segment, can be treated by syringing with Hartmann's cannula, which will drive out the cholesteatoma when there is need. Each syringing is followed not only by careful drying, but by dehydration effected by means of "drops" of alcohol. The surface of the osteitis is cauterised with chloride of zinc, after the cholesteatoma is removed.

In the case of a perforation confined to Shrapnell's membrane, extraction of the cholesteatoma is impossible, because the perforation is too narrow and does not permit of the stream of water being directed in every direction; even the water which is injected is retained in the attico-antral cavity; hence this treatment is quite insufficient.

Curative treatment.—*Opening up of the petro-mastoid cavity.*—For attico-tympanic suppurations there is only one operative procedure, namely, *complete opening up of the petro-mastoid region; partial opening up is to be rejected in these cases.*

We will not enter into the details of the classical technique of the present day. We will merely say that it is necessary to operate very freely and to shave

off as much as possible of the base of the bony casing of the facial nerve. Finally, curetting of the inner wall of the tympanum must be performed with a light touch.

The patient, after healing has taken place, must be under supervision. The epidermis which covers the new mastoid cavity is fragile and ulcerates easily. The attention which it requires is, however, very simple, namely, gentle removal of the crusts which have formed on the surface, with a swab moistened with liquid vaseline.

Partial opening-up.—*Attico-antral suppurations with perforation in Shrapnell's membrane* are amenable to the partial operation. One of us in a recent work ¹ has endeavoured to show why ossiculectomy (until now suggested as the treatment for these suppurations) was a mutilating procedure, incapable of bringing about a lasting cure. He states that the spontaneous mode of cure of these suppurations by *spontaneous atticotomy* brings about inevitable rupture of the chain of ossicles and consequently an irreparable loss of part of the auditory function, and suggests that we should not wait for this natural course, but that *surgical opening of the attic should be practised*. Here, as in acute otitis, spontaneous ruptures spells destruction of organs essential to the auditory function and *it must be forestalled*.

Atticotomy through the meatus being practically impossible and dangerous, it must be effected by the *trans-mastoid route*; this amounts to performing a partial mastoid operation by Bondy's method.

OPERATIVE TECHNIQUE.—The operation consists

¹ M. Sourdille, *Trépanation mastoïdienne élargie et atticotomie transmastoidienne*. Doin, éditeur, Paris.

Plate III



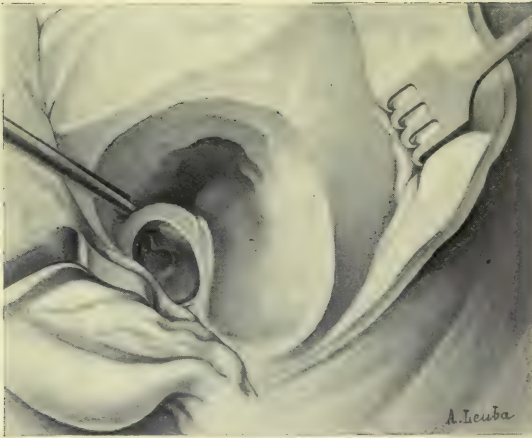
(1) Trephining of mastoid process has been carried out; the roof of the antrum, freely exposed, is directly continuous with the superior wall of the trephine orifice.



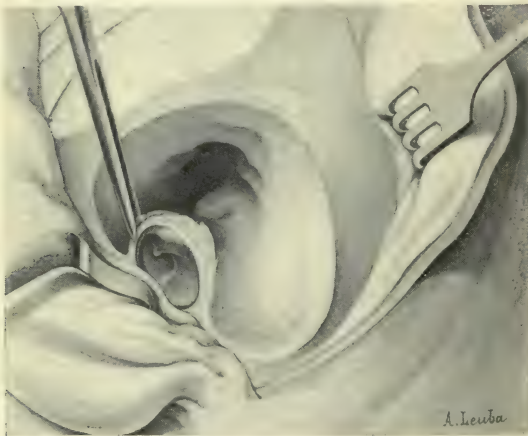
(2) 1st stage.—*Incomplete resection of the roof and of the posterior wall of the meatus.*—The external wall of the attic is no longer present except as a bony lamella of 3 mm. in thickness, and perfectly smooth.

[To face p. 32.

Plate IV



(1) *2nd stage.—Superior opening of external attic.*—A gouge, of the 3 mm. size, removes in small fragments the superior part of the plate. The roof of the aditus and of the tympanum forms the superior limit which must not be overreached. The osseous peritympanic ring protects the chain of ossicles.



(2) *3rd stage.—Breaking-down of the bridge.*—It is carried out at the anterior part of the osseous peritympanic ring, in front of the head of the malleus. Position of the gouge for the carrying out of this stage.

[To face p. 33.]

of three parts—opening of the antrum, opening of the external attic, and treatment of the soft parts.

First Part.—Opening of the antrum.—This is performed in the same way as in the complete operation; care must be taken to detach the membranous meatus gently and to avoid wounding the tympanic membrane.

Second Part.—Opening of the external attic.—This is a delicate part of the operation; it consists in removing, without touching the ossicles, the external wall of the attic, formed not only by the wall proper of the attic, but also by the roof of the external auditory meatus. The extent of the bone to be removed, from the meatus to the attic, is at least 15 mm., with a vertical thickness of from 5 to 6 mm.; its ablation must be methodical if the success of the operation is not to be compromised.

The technique which we have proposed consists of four stages.

1st stage.—Incomplete resection of the roof of the meatus.—Without resorting to heavy blows, the gouge must be driven fairly rapidly; it transforms the osseous wall, thick and oblique, into a well-defined thin level plate, on which the fine gouge can work with precision and without danger of slipping (Plates III and IV).

Exposure of the supra-jacent dura mater must be avoided and to this end *the direction of the roof of the antrum and of the aditus must be followed*, the level of which is indicated by the orifice of the mastoid trepanation.

2nd stage.—Superior opening of the attic.—This is performed by degrees from *behind forwards*, with a fine gouge of 3 mm. in size, which removes the whole of

the superior part of the plate just made ; the bone is spongy and is easily cut by *gentle blows, for at all costs a slip into the deep part must be avoided.* The gouge is held all the time above the ossicles which are protected by the osseous peri-tympanic ring, the next part to be resected.

3rd stage.—Breaking-down of the bridge.—This is not carried out in this instance as in the complete mastoid operation, from its posterior part to the level of the incus ; the bone is friable and the gouge, by its blow, nearly always detaches a small piece of bone, which, driven inwards, risks dislocation of the incus. It is at its anterior part, in front of the head of the malleus, that the gouge cuts it through.

4th stage.—Resection of the tympanic ring.—The part situated in front of the ossicles is first cut away, then the posterior part ; during this stage the gouge should be held as nearly as possible parallel to the ossicles (Plate V).

Third Part.—Treatment of the soft parts.—The attic is completely opened ; by means of syringing

EXPLANATION OF PLATE V

FIG. 1.—*4th stage.—Resection of the tympanic ring. It is carried out in small fragments from before backwards. Position of the gouge inclined parallel to the surface of the ossicles.*

FIG. 2.—*The completed operation : the bony casing of the facial nerve is shaved off as much as possible. The plastic flap is resected so as to show the operation cavity better.*

M. Malleus.

En. Incus.

A. Antrum.

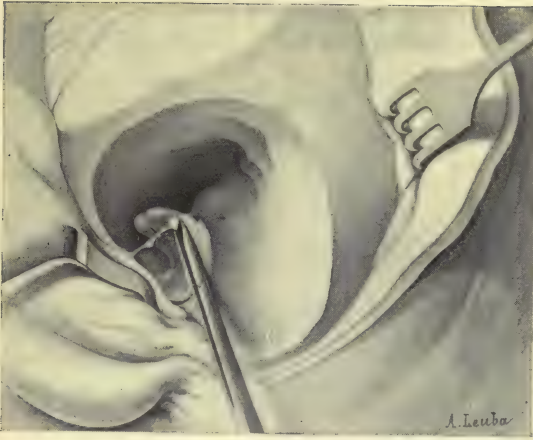
S. Projection of the horizontal semi-circular canal.

F. Facial nerve.

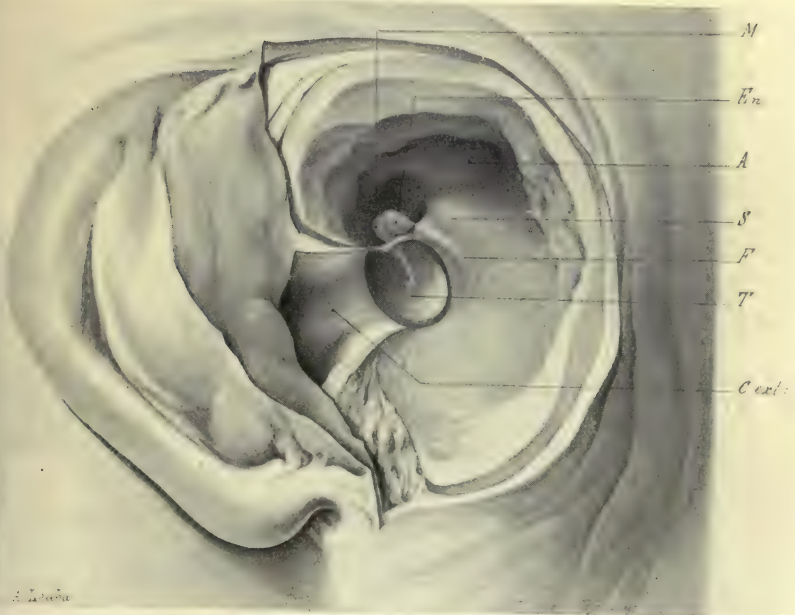
T. Tympanic membrane.

C. Anterior wall of the external auditory meatus.

Plate V



(1) 4th stage.



(2) Completed trans-mastoid atticotomy.

[To face p. 34.]

with Hartmann's cannula, the cholesteatomatous débris which block it up are removed. The ossicles are sometimes hidden under the granulations which cover them; we must not be insistent in clearing them; this can be done during the post-operative treatment.

We conclude by cleaning up the mastoid wound, and carrying out a large "plastic" of the meatus with an inferior flap, as in the complete mastoid operation, with suture of the retro-auricular wound. Finally the operation cavity is plugged with *iodoform gauze*.

POST-OPERATIVE TREATMENT.—This is of primary importance for the success of the procedure. Regular epidermisation of the operation cavity and cicatrisation of the attic and ossicles must be assured.

The dressing should be repeated every day.

In the first place the operation cavity and, above all, the attic should be syringed out with Dakin's liquid or Labarraque's solution well diluted with sterilised water (2 per cent.) by means of Hartmann's cannula, followed by careful drying and cauterisation, when necessary, of the granulations on the ossicles with a solution of chromic acid (1 in 30) or chloride of zinc (1 in 20), and finally dressed with small strips of iodoform gauze, as in a radical mastoid operation. After a week plain sterile gauze alone should be used for the dressing.

We repeat that the dressing should be carried out every day; without this there is a risk of the wound becoming infected and the healing retarded. It is only after cicatrisation of the osteitic lesions that the dressings may be less frequent.

The duration of the treatment is very much the

same as for the complete mastoid operation, from fifty to seventy days.

The hearing reappears suddenly after the first dressing ; it decreases on the following days, and then it increases progressively after cicatrisation and absorption of the connective tissue which may have developed about the ossicles.

RESULTS.—In the last patient operated on, after fourteen years of suppuration in the attic with cholesteatoma, complete cicatrisation took place by the sixty-eighth day after the operation. His hearing for the low voice increased from 0 m. 80 before the operation to 8 metres.

We shall publish later a series of our observations on this proceeding.

It has been reproached with being too full of detail and moreover *paradoxical*.

Full of detail it undoubtedly is, as the resection of the external wall of the attic is a delicate matter, but it is easy after some practice on the cadaver. Is it possible to perform the complete mastoid operation correctly, straightway, without previous practice ?

It is styled *paradoxical* in that it leaves lesions behind and removes healthy tissues. Do we profess, in the course of a complete mastoid operation, to remove all the osteitic lesions which exist on the internal walls of the attic and of the tympanum, particularly at the level of the fossa of the fenestra ovalis or fenestra rotunda ? These lesions heal secondarily, because the operation has done away with retention opposite them. It is the same with the partial opening ; the external ulcerated surface of the incus is here homologous to the inner wall of the tympanum. These lesions heal because they are laid bare and are

directly accessible to modified post-operative treatment.

In short, the *principle* of the partial operation is to treat the attico-antral lesions by exposing the antrum and attic in their entirety, by bringing to light the lesions without any mutilation of the chain of ossicles. The morbid changes in the latter are treated, in full view, in the course of the later dressings.

The result is *cure of the suppuration with preservation of the function of hearing*, an essential condition to secure the patient's intrinsic value. It is for this reason that the operation seems to us so important from the military and social points of view.

Ossiculectomy.—It used to be the classical saying (1) that all otorrhœas remaining uncured after appropriate medical treatment, are amenable to ossiculectomy in the first place, and failing that, to petromastoid opening; (2) that caries of the ossicles calls for ossiculectomy.

The first of these indications has met with fewer and fewer partisans, because ossiculectomy is an operation as mutilating as a mastoid opening, and it does not have any effect on chronic mastoiditis, the usual cause of the chronicity of otorrhœa.

The second indication does not exist for us so long as the caries of the enlarged ossicles has not caused rupture of the chain.

According to our opinion, ossiculectomy should find its principal indication in those cases of old-standing otorrhœa with great loss of tympanic substance, where the incus is most often eliminated and the antrum considerably reduced in size by condensing mastoid osteitis. The scanty but obstinate suppuration is often kept up in these cases by caries

of the head of the malleus or of the anterior part of the walls of the attic. The removal of the useless remains of this ossicle may bring about a very rapid cure.

Contrary to the classics, we never practise ossiculectomy when the lesions are situated *on the external surface* of the ossicles, as in suppuration behind Shrapnell's membrane, when the tympanic membrane is intact and the tympanum proper shut off ; we prefer to sacrifice the external bony wall of the middle ear, which has no essential functions, and to preserve its contents—the ossicles—which are indispensable organs for the auditory function.

A misunderstanding has long existed between the surgeon who declares himself satisfied when he has arrested a suppuration dangerous to life, and on the other hand the patient who is little concerned with regard to this, but is above all anxious to be able to hear. Both are right, and we must concern ourselves with the preservation of hearing power whilst putting an end to the aural infection ; now the curing of suppuration in the attic without destruction of the chain of ossicles ought to improve the hearing ; removal of the ossicles when the membrane is intact, aggravates the deafness enormously.

SECOND PART

WOUNDS OF WARFARE

CHAPTER I

WOUNDS OF THE EXTERNAL EAR

WOUNDS OF THE AURICLE

Etiology.—Wounds of the auricle are fairly frequent and chiefly as the results of bursting of grenades, which generally cause multiple superficial injuries of the face and scalp.

Isolated wounds of the auricle from bullets or fragments of shells are rarer. We have never observed any caused by sword-cuts.

Symptoms.—Every variety is to be seen, from simple scratches of the skin to perforating wounds or tears with partial or total loss of substance.

The wound may be situated on the free margin, the concha, the lobule of the ear or the tragus; a projectile which strikes the auricle perpendicularly buries itself in the mastoid region, the parotid region or the muscles of the neck.

These wounds cicatrise rapidly by reason of the rich vascularity of the part. Sometimes, however,

they suppurate, especially the lacerated ones, where the bruised cartilage is exposed and when the treatment has been insufficient. The infection extends to the cartilage, whence chondritis follows; this is very obstinate and tends to elimination of the cartilage and to unsightly cicatricial contractions.

Loss of the auricle causes a certain amount of difficulty in locating sounds in space; closing up of the auditory meatus by a cicatrised stump affects the hearing injuriously.

Treatment.—The surgeon has a double aim, namely, to prevent infection and perichondritis, and to avoid post-cicatricial deformity.

The wound should be carefully *cleansed and sutured* as soon as possible after the injury; the contused parts should be resected with scissors, *but sparingly*; a suture at the perforated parts will prevent over-riding of the fragments.

If perichondritis takes place the affected portion of cartilage must be detached and excised as soon as possible with a bistoury; this is the only means of limiting the ravages. Later on, the cicatricial deformity should be treated.

In simple cases, auto-plastic repair, according to Morestin's method (so-called "game of patience") may be attempted; the cicatrised tissue is excised and cutaneous flaps liberated, then sutured one to the other.

But when the loss of substance is extensive and reaches the supporting cartilage, it is preferable to have recourse to a prothetic apparatus to hide the deformity. Pont, principal of the Prothetic Service of the XIVth Region, advocates an apparatus of plastic paste, which the patient models himself in

Plate VI



Prothesis of the auricle according to Pont's Method.

[To face p. 41.]

a mould previously prepared ; it is kept in position by a special kind of glue. In this way deformed stumps and partial or total loss of the auricle can be hidden.

The figures on Plate VI, kindly lent by the deviser, represent two cases of reparation carried out by this method.

WOUNDS OF THE EXTERNAL AUDITORY MEATUS

Etiology.—Injuries of the meatus are less frequent than those just mentioned, and they arise from the same causes. We will not here consider wounds of the meatus secondary to fracture of the cranium or a blow on the chin.

Pathological anatomy and symptoms.—Isolated lesions of the meatus occur almost exclusively on the external membranous portion.

Injuries of the osseous portion are always secondary to a fracture of the mastoid process or of the tympanic bone and are accompanied by lesions of the middle ear ; they will be considered along with injuries of the auriculo-mastoid region.

At the level of the auditory meatus or more deeply situated, either a penetrating wound with a single orifice, or more rarely a perforating wound, may be observed.

The lesion involves only the integuments or includes at the same time the cartilaginous skeleton : this is the usual occurrence.

Otorrhagia and pain induced by movements of the temporo-maxillary articulation are the two signs at the onset. The wound may heal aseptically.

Often, the projectile remains *in situ*, and causes a

suppuration which discharges itself exteriorly by the meatal wound. Healing is slow; the tissues become infiltrated and the cicatrization brings about a *stenosis* which interferes with audition; this is the great danger connected with an infected wound of the meatus.

Treatment.—Before everything, stenosis must be prevented. The cleansed wound should have its adhesions *divided in the line of the axis of the meatus*. It should be explored with a probe and the projectile extracted, if it has remained near the orifice; then plugging with dry sterile gauze is carried out.

The same division of adhesions and search for the projectile should be made, if suppuration is present. If the position of the wound is not favourable for satisfactory drainage, there should be no hesitation in making a counter-opening at the lowest part of the wound, which will allow of cicatrization of the meatus.

Treatment of the stenosis.—If simple dilatation by plugging does not bring about any result, recourse must be had to surgical treatment. This consists in making a retro-auricular incision, detaching the auricle and the posterior meatal wall, and excising the cicatricial part. Even this may not be sufficient, and according to the case, it may be found advisable to resect with a gouge a more or less extensive portion of the postero-superior *osseous wall*; the corresponding membranous wall will be excised or simply cut into a flap hinged below which will be turned down below and behind according to the method of “plastic” of the meatus usual in a mastoid operation. The proceedings will be concluded by suturing the retro-auricular wound while the meatus will be plugged until complete epidermisation has taken place.

CHAPTER II

INJURIES OF THE TYMPANIC MEMBRANE AND OF THE TYMPANIC CAVITY

Etiology.—Injuries of the middle ear are of frequent occurrence. One of us has made observations, in an Oto-laryngological Centre in the Interior, of 373 cases of traumatic median otitis out of a total of 6,171 patients examined between April 15, 1915, and October 1, 1916. The actual number is probably less, for certain patients have a tendency to attribute a traumatic origin to old-standing otorrhœas, which have been merely re-awakened; the error, however, cannot be a considerable one.

Foremost comes the frequency of ruptures of the tympanic membrane; and, in addition, many pass unobserved when they are associated with more serious wounds such as lead to the wounded man entering a general surgical department.

Most authors insist on the importance of former tympanic lesions being predisposing causes for injuries of the tympanic membrane; this is rational, but to what extent do they have this effect? It is almost impossible to determine this point for want of previous examinations, and because of the various circumstances accompanying the accident.

The determining cause is a direct shock on the

tympanic membrane. It is produced either by a solid projectile such as a fragment of a shell, a torpedo, a grenade, thrown-up gravel, or else by a violent displacement of the air which follows the deflagration of the explosion—"the air projectile."

Isolated injuries of the tympanic membrane and of the tympanum by a solid projectile, are rare; the curvature of the meatus guards against this; the wounding agent generally causes at the same time lesions of the mastoid region or of the meatus which we will consider in the next chapter.

The "air projectile," on the contrary, is the chief cause of localised injuries of the tympanic membrane and tympanum.

Pathogenesis.—The explosion of a projectile, setting a considerable mass of gas at liberty, causes two phenomena in its immediate neighbourhood, namely, violent driving back of the surrounding air and a sudden elevation of the atmospheric pressure, the latter being all the more intense if the projectile bursts, so to speak, in a closed vessel—a dug-out or a trench.

The projected air enters the external auditory meatus which lies in the direction of the projectile; it comes up against the tympanic membrane which ruptures; the lesion is then unilateral.

Increase of pressure may act on the two tympanic membranes, so that they may burst simultaneously; the lesion is then bilateral.

Thus we think we can explain the fact that those who are injured when in the open nearly always present unilateral lesions, or more marked on one side than the other, whilst those who are injured in the trenches have more often bilateral lesions.

An endeavour has been made to explain, by the inverse phenomena (aspiration and diminution of the atmospheric pressure), the disorders provoked by the bursting of a shell. Where the ear is concerned, we admit the action of compression. Compression is the phenomenon which occurs first ; why not admit that it is the most guilty ? The reaction is certainly less intense and less sudden than the action. Why should a tympanic membrane resist the latter and yield to the former ? Further, the articulation of the incus and the malleus is such that the movements outwards of the tympanic membrane are not transmitted to the liquid in the labyrinth. How are labyrinthine disturbances associated with explosion to be explained, if not by sudden compression ?

Pathological anatomy.—Lesions of the tympanic membrane vary from simple contusion to rupture.

Tympanic contusion.—Contusion has been recently described by Saupiquet.¹ We ourselves have noted it several times. It shows itself as a small interstitial hæmorrhage, lenticular in shape and of varying length, which may be situated anywhere on the membrane but more often along the handle of the malleus.

According to this same author it may be situated on Shrapnell's membrane ; such a localisation must be rare ; we have never observed it. The hæmorrhage becomes absorbed during the following days, leaving the membrane intact, or it is transformed, according to Saupiquet, into a secondary tympanic perforation (??).

Rupture of the tympanic membrane.—More often the

¹ SAUPIQUET, *Lésions de l'oreille moyenne*, "Revue hebdomadaire de Laryngologie," December, 1916.

tympanic membrane ruptures under the violence of the shock.

The resulting perforation is generally an isolated one. We have, however, observed a few cases of double or even triple perforation, one being separated from the other by a little bridge of tympanic membrane.

Its situation is variable; it may occupy one of the quadrants—anterior, posterior, superior or inferior—but it is found most frequently in the inferior and posterior segments. We have never seen one at the level of Shrapnell's membrane; perforations in the flaccid zone are, in our experience, always pathological.

The loss of substance may be central, peripheral or marginal.

The shape varies with the size; it is sometimes punctiform, sometimes linear, sometimes round, oval or reniform when the antero- and postero-inferior quadrants are attacked simultaneously. Almost complete disappearance of the membrane may also occur. The aspect at the outset is characteristic; the edges are torn, indentated, bleeding and surrounded by a narrow hæmorrhagic margin (Molinié).

Later, after cicatrisation, these characteristics disappear and it becomes difficult to distinguish between the traumatic perforation and a pathological one, especially if the tympanic injury has suppurated.

Anatomical course.—The course varies according as to whether the tympanic wound becomes infected or not.

(1) *The tympanic wound remains aseptic.*

The rupture has not been produced by the contact of an infective agent; the curvature and the depth

of the external auditory meatus protect the wound against infection from without.

Two courses are possible—the perforation may close or else the edges may epidermise and the perforation become permanent. Small and medium-sized perforations have certainly a greater tendency to close up than the larger ones; but there is nothing certain about this; all depends on the vitality of the tissues of the tympanic membrane.

It has seemed to us that perforations situated in an atrophic tympanic membrane, as also the marginal ones ordinarily limited to the postero-inferior segment, have most difficulty in healing.

(2) *The tympanic wound becomes infected.*

This infection arises from three causes:—First, at the time of the traumatism, débris of earth and gravel have been carried with the air into the auditory meatus as far as the tympanic membrane; or else the patient has been buried, thrown to the ground and rises again covered with dirt; spontaneous efforts to clean the meatus have only had the effect of pushing the débris further in.

Further, the patient has blown his nose, perhaps violently, with both nostrils closed. A little mucus from the Eustachian tube or naso-pharynx has been driven into the tympanum and has infected it.

But the greatest cause of infection exists in *medicated lotions and inopportune instillations of "ear-drops."* On arriving at the aid-posts, all the wounded who suffer from bleeding from the ear run the risk of having their ears syringed; this proceeding carries into the tympanum débris of cerumen mixed with mud, and leaves at the bottom of the meatus a drop of dirty water, inevitably causing

infection. Some who are more moderate know that syringing is harmful, but they cannot resist the temptation to instil glycerine in some form, carbolised or otherwise. This creates at the bottom of the meatus a humid condition favourable to infection. Do not we know that certain cases of suppurative otitis get well only after the suppression of glycerine instillations, and after the use of absolutely dry dressings?

Suppuration which arises in this way appears in three, four, five, or, it may be, eight days after the injury, sometimes later, according to how early the infection has taken place.

Other lesions of the tympanic membrane.—Rupture of the tympanic membrane is ordinarily the only ascertainable lesion. Do there exist, as some think, dislocations or ruptures of the ossicles? We have never seen evidence of such.

Tympanic lesions may be unilateral or bilateral, but in the latter case the two ears are not usually affected in the same degree.

Symptoms.—(1) **Aseptic form.**—Two signs direct attention to the ear—otorrhagia and deafness.

Otorrhagia is generally slight; a few drops appear in the auditory meatus. This hæmorrhage may even be absent. As in injury of the limbs, the violence of the rupture brings about hæmostasis of some sort; a little drop of effused blood remains adherent to the tympanic membrane.

The *deafness* is equally variable; it appears at the commencement or a few days later; it varies from simple dullness of hearing to complete deafness, with subjective noises (buzzings and whistlings); but these severe symptoms arise from concomitant labyrinthine lesions.

Objective examination.—At first, a small interstitial hæmorrhage of the tympanic membrane or, more often, a little coagulated blood in the depths of the meatus, more or less hiding a traumatic perforation of the tympanic membrane, is observed.

We will not dwell on those characteristics which we already know.

A punctiform perforation is revealed by Valsalva's test; a bent probe will penetrate the tympanic ring in cases of marginal openings. All other perforations can be recognised at the first glance; the pale gray mucous membrane of the typanum can be seen through them. The ossicles are intact.

This complete otoscopic examination is only possible after spontaneous breaking down of the clot which must be treated with respect so as to avoid a traumatism which is always harmful.

Examination of the hearing.—The deafness varies considerably according as the internal ear has escaped or, on the contrary, has been concussed by the same shock. These concussions form the subject of a special chapter and need not delay us here.

A simple perforation of the tympanic membrane may cause either a hardly perceptible deafness or, on the contrary, a marked one; if very small, it produces scarcely any weakening of the hearing power, but it would be very inexact to say that the hardness of hearing is in proportion to the extent of the loss of substance, and otoscopic examination cannot show the extent of the functional disturbances.

However, according to Maurice, perforations situated opposite the fenestra rotunda would give rise to a greater amount of deafness, for the following reason: an intact membrane transmits the sonorous

vibrations to the fenestra ovalis; the liquid in the labyrinth is driven back and, being incompressible, drives back in its turn the membrane of the fenestra rotunda; if the latter is rigid, the endolymph will be rendered immobile and the organ of Corti will not be set in vibration. Let us suppose there is a tympanic perforation situated opposite the fenestra rotunda; the sonorous vibration which knocks against the fenestra ovalis strikes simultaneously and directly the fenestra rotunda, and the labyrinthine fluid becomes immobile.

In fact, we have, a long time ago, seen patients with large posterior and inferior perforations, whose hearing was suddenly and *enormously* increased by introducing a pellet of cotton wool at the level of the fenestra rotunda. Thus the excellent but too rare good results of the use of artificial drums are to be explained.

It is unnecessary to dwell on the responses to the various hearing tests—preservation of bone conduction, diminution of air conduction, lateralisation of Weber to the affected side.

It may seem surprising that a traumatism violent enough to cause the tympanic membrane to burst most often leaves the labyrinthine function intact; rupture of the tympanic membrane ordinarily saves the internal ear.

This result is perhaps brought about by a double mechanism. In the first place, rupture of the elastic fibres of the middle layer of the tympanic membrane deadens the violence of the shock at the same time that it diminishes the extent of the surface of reception. Next, the projected column of air, penetrating through this perforation into the tympanum, produces an *actual*

damming-up of the labyrinthine fluid. The pressure which it exerts on the fenestra rotunda opposes the displacement on the outside of the fenestral membrane, and consequently check the driving-in of the stapes whether alone or combined with that of the tympanic membrane.

(2) **Suppurative form.**—Suppuration shows itself some days after the injury by pain in the ear and purulent discharge.

The pain is ordinarily much less severe than in acute idiopathic otitis; the tympanic perforation, preceding the suppuration, prevents the accumulation of pus in the drum and suppresses the distension. The actual pain is chiefly caused by retention; it is intense if the perforation is too small; there is simply a sensation of heat in the ear if the perforation is large; sometimes the dull pain of latent mastoiditis, with feverishness and constitutional disturbances, is present, indicating that the mastoid is involved.

The *purulent discharge* is also variable in quantity, sometimes reduced to a few drops of serous liquid, while in other cases it is very profuse and decidedly purulent.

Objective examination, after the meatus has been cleansed, reveals a perforation of the tympanic membrane which is red and tumefied as is also the visible aural mucous membrane. In a few old-standing cases this mucous membrane appears granular, polypoid and sometimes even ulcerated, and the probe comes in contact with superficial osteitic lesions.

The *deafness* is much more marked than in the aseptic form and, above all, more lasting on account of the adhesions following the suppuration.

The course of traumatic suppurative median otitis,

with the exception of the slight cases which become cured in a few days, has appeared to us to have a much more gloomy prognosis than that of acute idiopathic otitis. The latter, caused by the development on the healthy aural mucous membrane of infective germs which have already invaded the organism and which had come from a neighbouring region, has generally a cyclical course. Apart from the rare cases where, owing to feebleness of the organism or from the extreme virulence of the pathogenic agents, deep lesions are produced which aggravate the prognosis, the suppuration ordinarily presents a spontaneous tendency to dry up; it is only necessary to prevent retention and stagnation of the pus as well as secondary infection. Infection of the mucous membrane of the tympanum has a course similar to that of the nose, namely, serous, purulent, muco-purulent discharge, then dryness.

The course of an acute traumatic otitis is quite different. The abrasion of the tissues, the possible presence in the tympanum or the depths of the meatus of débris of earth acting as a foreign body, the virulence and multiplicity of the infective germs, until then foreign to the organism, all explain the profuseness and persistence of the suppuration and the absence of any tendency to spontaneous cessation of the discharge.

The war has brought to our notice, in connection with the ear as with the limbs, infections of a severity unknown in time of peace.

It is difficult to fix an average duration for traumatic suppurative otitis. Rarely limited to a few days in cases where the infection of the tympanic wound is of Eustachian tubal origin, the duration too often

runs into weeks and months ; healing is frequently imperfect with persistence of the perforation, cicatricial bands and the possible recurrence of suppuration.

Acute traumatic otitis is sometimes complicated by acute mastoiditis. Out of 373 cases of traumatic otitis, we have observed it 12 times. Most of them came from the Front almost simultaneously, in two or three batches ; was this a coincidence of some special defect in treatment or of an influenzal surrounding ?

The course of the mastoid lesions shows nothing unusual. They heal normally, after the trephining, whilst the ear often does not dry up. Is this persistence of the otitis to be attributed to incomplete or to too tardy intervention ? Yes, in many cases ; but that is not the only reason. The persistence of a tympanic discharge depends fairly often on a deep-seated affection of the mucous membrane or on the presence in the depths of the tympanum of microscopic foreign bodies. More often these cases of otitis have appeared to us difficult to cure even after the mastoid operation, and even when this had been carried out by different operators, with among them some of the highest reputation.

Prognosis.—The prognosis of the aseptic forms is relatively favourable. Anatomical *restitutio ad integrum* depends on the size of the perforation and the vitality of the tissues. As for the hearing, it is influenced by the extent and the situation of the perforation, by causes which escape our notice and above all by the state of the labyrinth.

The suppurative forms have a more gloomy prognosis. We have not come across any which

have been the cause of death by immediate complications, but the persistence of an obstinate otorrhœa is not without danger. The prognosis as to function is always mediocre, even if the suppuration ceases and the perforation becomes cicatrised; the hearing remains poor on account of the cicatricial bands and the adhesions which have formed.

Diagnosis.—A recent aseptic perforation is recognised by the presence of the clot, the extravasation of blood from the membrane and the red margin round the orifice.

A diagnosis made later on is much more difficult; a whitish tract, an atrophic zone, bear witness to cicatrised of an old perforation, but there is nothing to show its traumatic nature. If there is a persistent opening, of a serrated appearance with notched edges, soundness of the tympanic lining is evidence in favour of trauma, but this does not afford absolute certainty.

Only the former history remains to establish the accidental origin of the suppurative forms, and its evidence must be taken with reserve.

Treatment

The aseptic form.—**Immediate treatment.**—The line of conduct to be followed when a recent rupture of the tympanic membrane is present, may be summed up in two words—complete *abstention*.

The doctor and his assistants should absolutely avoid all moist treatment of the ear; they should practise no syringing, no instillation. If absolutely necessary, the external auditory meatus may be cleansed with dry cotton-wool, care being taken not

to drive any foreign body into the deeper part. A simple plug of cotton-wool or a dry dressing, thicker when there is profuse hæmorrhage, should be used to stop up the auditory meatus whilst waiting for the transference of the patient to a special clinic.

There, the otologist, under the control of the forehead mirror, proceeds with a very detailed cleansing of the meatus by the dry method or with slightly moistened cotton-wool. He will be careful not to injure the tympanic membrane. He will conclude by introducing a strip of aseptic gauze.

With these precautions, the hospital treatment required is of *very short duration*.

Later treatment. — *Tympanic prothesis.* — A dry unilateral perforation of the tympanic membrane, with preservation of the function of the other ear, does not require any further treatment than care to prevent the water used for washing purposes or the bath entering the middle ear. But we too often come across the association of a traumatic median otitis of one side with extreme labyrinthine deafness, due to concussion or some other cause, of the opposite side. The functional incapacity may, therefore, be considerable. We are powerless with regard to the labyrinthine deafness; we can sometimes greatly ameliorate the deafness of the ear which is simply perforated, provided that the functions of the cochlea are preserved, and the importance of such an amelioration is great; we look for it in the results of prothesis of the tympanic membrane; it must be confessed that successful results are rare, but they are sometimes so decided that this tympanic prothesis should always be tried, provided the ear is absolutely dry.

A description of the various forms of artificial

drums will be found in classic treatises. We shall confine ourselves to describing the technique adopted by one of us (Bourgeois) for many years. It is extremely simple.

As material for an artificial membrane, a thin layer is cut from the very fine indiarubber ordinarily used by electricians. Its form and its dimensions are such that it will amply cover up the loss of substance in every direction; it is sterilised by boiling, as is also, at the same time, a concentrated solution of tragacanth. After cooling, the thin fragment of gum-elastic is plastered over on one side with the solution of gum, seized with fine bent forceps and applied to the tympanic membrane; a bent probe causes it to slide on to the membrane till it is placed in the right position. The patient makes a "Valsalva" movement which drives the tympanic membrane against the indiarubber, and testifies as to the absence of any escape of air. It is again put in position and the patient is asked not to blow his nose for several hours.

The results of this practice are not always the same.

Some patients complain of a disagreeable resonance, of noises or a feeling of foreign body, and they will not tolerate the artificial membrane. Others derive no benefit from it; in others again it produces an oozing from the ear, which causes the indiarubber to become detached and shows that it is not tolerated. These are the unfavourable cases.

Other deaf subjects, unhappily too rare, find an increase in their hearing from the shouted voice on contact to the spoken voice at one or two metres;

they will not live without their artificial drum. They should be seen every month at first, then, later, three or four times a year.

Again, in certain others, the success is complete in that the presence of the indiarubber stimulates the vitality of the tympanic membrane so that the perforation may be seen to close up of itself and thus render the artificial drum henceforth unnecessary.

The suppurative form.—The treatment of traumatic suppurations differs entirely from that of acute idiopathic otitis. Asepsis and satisfactory drainage are sufficient to cure the latter, while for traumatic otitis, at least in the severe forms, *antisepsis cannot be dispensed with*.

During the first few days the meatus is full of thick, coloured, often fetid pus. Our first care is to cleanse the region; the hair should be cut with scissors, the meatus plugged with non-absorbent cotton-wool, and the auricle and neighbouring parts washed first with soap and then with alcohol.

The meatus is cleansed from pus by syringing with Hartmann's cannula which the otologist himself guides under the control of the forehead mirror; he will not forget to direct the stream on to the floor of the tympanum, thus driving out any foreign bodies that may be present. An antiseptic should be added to the tepid water: peroxide of hydrogen or, by preference, Labarraque's solution in the strength of 5 per cent. Dakin's Liquid has given us equally good results. After drying, a small plug of aseptic gauze is introduced into the meatus, and finally a thick dry occlusive dressing is applied.

This treatment should be renewed, according to need, once or twice a day.

There should be no hesitation in performing a paracentesis at the site of election, if the perforation is small and retention certain.

Later on, when the pus becomes clear, the syringing should be followed by an application of chloride of zinc (1 in 50) or by an ear-bath of a solution of nitrate of silver (1 in 100). The granulations should be cauterised.

Later on still, when the pus becomes less profuse, the syringing should be stopped and, according to the case, one or two baths of nitrate of silver (1 in 30), instillations of boricated alcohol and insufflations of boracic acid powder used. The plugging should be dry.

If mastoiditis supervenes during the course of the disease, the ordinary treatment is employed, that is to say, the classic mastoid operation; while the treatment of the lesions of the tympanum and tympanic membrane should be continued as we have just indicated.

CHAPTER III

WOUNDS IN THE AURICULO-MASTOID REGION

Etiology.—***Frequency.***—These injuries are rare. Out of 700 cases of war ear-lesions observed at the Limoges Centre, we found only 12 auriculo-mastoid wounds, namely, 1·6 per cent. ; we may add to these 4 cases recently observed elsewhere. Lannois and Chavanne have only noted 38 out of a total of 1,000 cases of war deafness, namely, 3·8 per cent. No doubt a certain number escape our notice ; these wounds are treated at once in the general surgical clinics ; but the otologist is often called in to attend to the secondary deafness. The extreme rarity of these cases depends partly on their seriousness ; such lesions of the lower part of the skull must cause death on the battlefield, and those which come before us are in the main only the milder forms. Out of 336 wounded (who were unable to be moved) treated lately in our ambulance (Bourgeois), there were 31 with wounds of the skull, of which only one had involvement of the mastoid region.

The determining cause is always a solid projectile, a bullet from a gun or shrapnel, splinters from a shell or grenade, some small and multiple, others large and single.

The projectile strikes the region of the ear in one of three directions—perpendicular, parallel or oblique; hence there is a certain amount of diversity in the resulting lesions.

Pathological anatomy.—Auriculo-mastoid injuries caused by weapons of warfare are somewhat different from those observed in civil practice. In the latter, usually the result of attempts at suicide, the weapon is almost invariably applied at the level of the external auditory meatus; the latter regulates to a certain extent the direction of the feebly driven projectile and the situation of the lesions, by its anatomical configuration and mode of resistance. Le Mée¹ has made a very complete study of this subject in his thesis.

The great force of the projectile of warfare, the variability of the direction and point of penetration, give rise to disorders which defy all definite laws.

However, we have been able to distinguish four varieties among the cases which we have observed:—

(1) *Tangential wounds*, in which the projectile has only just grazed the surface of the mastoid.

(2) *Plunging wounds*; these arise from a fragment of a shell, generally of considerable size, which approaches the mastoid region directly or obliquely; it drives before it the superficial layers, the resistance of which weakens its power of penetration.

(3) *Penetrating wounds*; the projectile enters deeply into the tissues and remains embedded in the mastoid process or the middle ear.

(4) *Perforating wounds*; a bullet coming at full speed penetrates the auriculo-mastoid region, traverses it more or less deeply, and emerges close by or at a

¹ LE MÉE, *Des coups de feu dans l'oreille*, Thèse de Paris, 1910.

distance, it may be even through the opposite auricular region. Sometimes the projectile lodges in an adjoining region—the brain, the nape of the neck, or the bony framework of the face.

The lesions caused by these violent traumatism's are seldom limited to the mastoid process.

The auricle and the membranous auditory meatus, which protect its anterior and exterior surfaces, may be struck in the first place, cut off or lacerated.

The mastoid process is merely grazed in tangential wounds ; the soft parts are injured, but on the external cortex there is scarcely even a simple groove or small fissure to be found. This, however, may extend fairly deeply ; in a case of this kind we observed actual hæmorrhage of the tympanum, at the level of the postero-superior quadrant of the membrane.

The mastoid process may be totally or partially broken down by the projectile which remains embedded or continues its course. The cells, the antrum, the aqueduct of Fallopius are opened ; the internal and external cortex are reduced to splintered fragments which project into the depth of the wound.

Fracture in the mastoid region includes that of the osseous auditory meatus and the peri-tympanic ring ; the tympanic membrane is ruptured, the ossicles dislocated and the tympanum opened. The roof of the antrum and the attic, and the external wall of the labyrinth may be destroyed or fissured by the projectile itself or the spreading of a fissure from the mastoid fracture. In the latter case, according to the experience of Le Mée, irradiation of the fracture takes place above towards the temporal bone, below towards the tympanic bone and the tympanum, and inwards towards the internal ear, tending to isolate

the mastoid process and the semi-circular canals on the one hand, and the petrous bone and cochlea on the other.

Finally, the lesions may extend beyond the limits of the organ of hearing; the meninges and brain, the intra- and extra-petrous branches of the facial nerve may be affected. We have not ourselves observed, nor seen mentioned by others, lesions of the carotid or sinusal vessels.

Course.—These wounds very often become infected and suppurate profusely, especially when they are accompanied by opening of the tympanum. The mastoid is infected step by step through the inter-cellular communications, as in the case of an actual mastoiditis.

The anfractuosity of the wound and the presence of loose splinters forming a foreign body, cause the suppuration to have no tendency to spontaneous recovery. Cicatrization takes place partially; one or two fistulæ may persist to show that the suppuration is still present; it indicates a menace of serious complications.

Symptoms.—The wounded man loses consciousness at the moment of being wounded. He is still more or less in a condition of shock when he arrives at the ambulance. He bleeds profusely from the affected region and sometimes presents a complete or partial facial paralysis of the same side. Further, he is generally completely deaf in the injured ear; giddiness, vomiting, spontaneous nystagmus, indicating a severe affection of the anterior and posterior labyrinths, may even be observed as well.

An objective examination of the wound does not reveal the exact extent of the lesions; those of the

soft parts, of the auricle and the membranous auditory meatus are evident; the existence of a mastoid fracture can be easily discovered by palpation. The blind introduction of a probe into the depth of the wound is a dangerous and useless proceeding; undoubtedly it would give some information as to the presence or the situation of an embedded projectile or of loose splinters of bone, but the dura mater or the lateral sinus may be exposed and there would be a risk of injuring them if the patient made the slightest movement.

Otoscopic examination is not always possible; fracture of the meatus and profuse bleeding may stand in the way; if not, the tympanic membrane will be seen either intact or ruptured, with or without hæmorrhage of the tympanum.

The appearance of the wound is quite different when the wounded man arrives some days or some weeks later at the otological centre. Cicatrisation will have already commenced, and the *auditory meatus is very often stenosed* (four times out of twelve). The wound no longer bleeds; it suppurates, especially if the tympanum has been opened and the early necessary operation has been deferred or incompletely performed. The integuments are infiltrated and the fetid pus empties itself externally by one or more fistular orifices which have granular edges and are situated in the meatus or on the external surface of the mastoid.

The wounded man complains sometimes of great pain and headache localised in the temporo-occipital region of the affected side.

Examination of the hearing gives varying results; a lesion limited to the mastoid region produces no

defect of hearing-power, such an event, however, being rare; likewise fairly severe dulness of hearing, due to obstruction of the auditory meatus or to lesions of the tympanum, affecting the aerial transmission of sounds, with preservation of bone-conduction and lateralisation of Weber to the affected side, is an equally rare event; in general, that is to say in the great majority of cases, the labyrinth is affected, the ear is totally deaf and there is vertigo; these functional disturbances indicate the labyrinthine concussion from a blow on the cranium, which we shall study in the following chapter.

The general condition is good, unless there is retention of pus or an intra-cranial complication.

Complications. — **Facial paralysis.** — Facial paralysis is the most frequent complication; it most often appears at the time of the mastoid trauma. According to our observations (3 cases), and those of Moure (7 cases) published in the *Presse Médicale*,¹ the facial nerve is nearly always affected in its intrapetrous portion (9 cases out of 10). It becomes compressed, lacerated, or cut through partially or totally by splinters of bone.

Facial paralysis is most often complete, involving at the same time the superior and inferior branches of the facial nerve; it may be partial, in which case it is susceptible of amelioration by appropriate treatment according to the degree of damage of the nerve.

Temporo-maxillary ankylosis. — We have seen this ankylosis twice; it results from different lesions:—

Direct injury of the joint by the projectile or a fragment of fractured tympanic bone.

¹ MOURE, *Paralysies faciales de la guerre*, "Presse Médicale," April 13, 1916.

Inflammatory reactions of the synovial membrane, caused by the neighbouring suppuration.

Retractile cicatrisation of the peripheral tissues.

Reflex contraction of the masseter muscles, on account of the pain round the ear which is caused by the movements.

Meningeal and cranial complications.—Personally we have seen none of these. We have noted in two of our operation cases, exposure in one of the dura-mater over a surface of 1 square centimetre, and in another rupture of the dura-mater by a splinter of bone; the meningeal orifice was covered over by the inferior surface of the temporal lobe. These two wounded men recovered without any signs of infection.

There must undoubtedly exist less fortunate cases, where the rupture of the meninges is followed, as in any other fracture of the skull, by infective complications; these may arise early or late.

In the first case there is acute meningitis or diffuse meningo-encephalitis, which rapidly ends fatally. In the second, the lesions have a tendency to become localised; they may vary from an extradural abscess, with a favourable prognosis, to a deep-seated abscess of the cerebrum or cerebellum, necessarily a very serious condition.

Lateral sinus and internal carotid.—The lateral sinus and the carotid may be opened at the same time as the injury, primary fatal hæmorrhage resulting before any intervention is possible. Later on the sinus may be affected by the spreading of the infection, causing thrombo-phlebitis or possibly septicæmia. We have never observed such a case.

Diagnosis.—The diagnosis of an auriculo-mastoid

wound is, so to speak, evident. The difficulty commences when we try to determine the extent of the deep lesions. Clinical examination does not always give the necessary information; it must be completed by X-ray examination.

Radioscopy of the mastoid region is insufficient; it merely discloses the more marked injuries and large projectiles.

Radiography is indispensable; it should be carried out in the oblique position. In the case of an embedded foreign body, we must have resort to the localiser, and a Hirtz or Marion-Danion compass will often be of the greatest service in the course of an operation.

In order to trace a meningeal, cerebral or cerebellar complication, we employ the usual means for examining these organs in otorrhœic subjects, namely, lumbar puncture, the investigation of the equilibrium in standing upright and walking, as also Barany's reflexes.

Prognosis.—An exact prognosis is impossible to establish, as we have no statistics as to the immediate mortality.

The prognosis *ad vitam* of auriculo-mastoid injuries observed a certain time after the trauma, seems good; it depends above all on the condition of the meninges and appropriate treatment.

As to the auditory function, it is unfortunately very often affected, total labyrinthine deafness being generally permanent.

Treatment

General indications.—Auriculo-mastoid wounds with fracture of the mastoid process, call for surgical

treatment; this should be carried out early, but is not necessarily of extreme urgency unless a profuse hæmorrhage demands immediate hæmostasis.

The early treatment has for its aim exploration of the seat of the fracture, the removal of any cause of compression likely to injure an important organ, the prevention of infection by surgical cleansing of the wound, and, finally, the re-establishment or modification of the anatomical condition of the soft parts of the ear, in view of its functions, in particular the *avoidance of stenosis of the meatus*.

All serious operations on the ear or its neighbouring parts require special instruments and a knowledge of the particular technical proceedings on the part of the surgeon.

Immediate treatment.—At the aid-post or the ambulance, cleansing of the wound and its edges in such a way as to avoid infection is all that is required; the hair should be cut, the auriculo-mastoid region shaved and then treated with ether or tincture of iodine.

As the tympanum may be opened by a tympanic rupture or fracture of the meatus, great care must be taken to avoid the entrance of any liquid into the middle ear; there should be *no syringing or instillations of drops*; a simple dry dressing should cover the wound while awaiting rapid transference of the wounded man to a special hospital at the front, where the necessary surgical intervention will be carried out.

Early operative treatment.—Tangential wounds. —It is sufficient to treat the soft parts which have been injured by means of disinfection, removal of dead tissues and sutures. We know what to

do for lesions of the auricle and the membranous meatus.

We need not occupy ourselves here with chipping or fissure of the external cortex; it heals spontaneously. We should keep an eye on the condition of the tympanum, and the course of any slight intra-tympanic hæmorrhage which may become absorbed without suppuration; should suppuration take place, the treatment should be that for an acute traumatic median otitis, namely, paracentesis and even mastoid trephining if the infection extends to the mastoid process.

Wounds with fracture of the mastoid process.—This is a variety of fracture of the cranium; surgical exploration is called for.

The complex anatomical nature of the region, the close proximity of vital organs, the position of which is not absolutely fixed in relation to the external landmarks, call for prudent and methodical exploration. The variability of the seat and extent of the lesions, stands in the way of operating according to a technical rule; the surgeon must, however, be guided by some general principles.

(1) The exploration to be complete must not be limited to the superficial layers; the mastoid trephining must be extensive and must allow of examination of the deeply-seated organs.

(2) The surgeon must not, at the commencement of his operation, be guided exclusively by the lesions.

He will take the bearings for his exploration in relation to an exact point which will all the time indicate to him the situation of the organs to be avoided. The fundamental mark for the mastoid is *the antrum*, a veritable cross-road which leads in

front towards the tympanum and external auditory meatus, behind and below towards the facial nerve, inwardly towards the labyrinth, above towards the meninges and cerebrum, behind towards the cerebellum and lateral sinus. *The exploration and opening of the antrum constitute the first stage of the operation.*

(3) At the first onset to keep away as much as possible from the injured area, so as not to mobilise or loosen the obstructing fragments until after having made a sufficient lateral opening to avoid injury of the deeply seated organs.

We shall then conduct the operation as follows :—

(a) *Trephining the antrum.*

The usual retro-auricular incision without regard to the position of the cutaneous orifice of penetration of the projectile.

Exploration of the antrum :—

At the site of election if the focus of the fracture is not found at this level.

Lower down at the level of the tip, if the fracture of the bones occupies the angle formed by the supra-mastoid ridge and the posterior margin of the auditory meatus. We return towards the antrum by following in its depths Lombard's cellular inter-sinuso-facial tract, and by resecting the external cortex with a gouge forceps.

(b) *Gradual widening* of the orifice of trepanation, by steering towards the *focus of the fracture which we attack from its periphery.*

Ablation of the splinters of bone, of the projectile itself and of the bone beyond the traumatised zone.

The operation-cavity must be easily visible in its whole extent, once the operation is completed ; the surgeon will explore it with the eye and the probe

in order to be sure that no mobile fragment remains on any of the walls, that there may be no zone of retention or stagnation during the healing and that the drainage may be efficacious. He will pay special attention to the posterior margin of the bony meatus, which will be left in its place if normal, and resected if fractured. We finish up by suturing the upper two-thirds of the wound; if desired, a drainage-tube may be placed in the lower angle of the wound; it must only be left *in situ* for a few days; no plugging should be employed; rapid healing without suppuration will take place if we are wise enough to avoid any exploration, applications and later interference with the cavity.

This technique is reserved for those cases—rare, it is true—where the injury is purely a mastoid one, without laceration of the auditory meatus. When this has taken place, the operation is concluded in a different manner, namely, as in the last part of a petro-mastoid opening, either by resecting the posterior wall by cutting out of it a large posterior flap, according to the shape of the mastoid cavity and the preferences of each operator. To finish, total suture of the retro-auricular incision will be carried out; the dressing should be done through the meatus; it consists of plugging so as to allow of drainage and the preservation of a large meatus. The wound will heal by filling up and epidermisation.

Infected wounds. — *Traumatic mastoiditis with integrity of the meatus and tympanum.*—Trephining a fractured and infected mastoid process follows the same principles as the treatment of an ordinary mastoiditis. The infection is supposed to have reached all the cells by gradual stages; the mastoid

process must be opened from above downwards after total resection of the external cortex and with exposure of the aforesaid aberrant cells. To confine ourselves to the obvious apparent lesions, to open the antrum at its inferior part, to neglect the deep cells of the tip or the retro-facial ones, or again the postero-superior, is to condemn the wounded man to the formation of fistulas and to repeated operations; the experiment must not be made.

It was a good thing when we gave up plugging mastoid cavities; we suture their upper part, more or less completely, and employ simple dressings.

Traumatic mastoiditis with laceration of the membranous meatus and integrity of the tympanum.—Extensive trephining, as above stated, partial resection of the osseous meatus, resection of the posterior wall of the membranous meatus. Total retro-auricular suture. Dressings through the meatus.

Traumatic mastoiditis with traumatic median otitis.—The hearing is generally permanently damaged; there should be no hesitation about practising at the first onset a classical petro-mastoid opening, unless perhaps the aural lesions appear to be only very slight. The mastoid operation is nearly always called for.

Treatment of complications.—*Facial paralysis.*—We shall only concern ourselves with the facial paralysis which is secondary to an intra-petrous lesion.

It is sometimes kept up by simple compression from a fragment of bone or perhaps an effusion of blood, sometimes by contusion of the nerve which may at the same time be partially lacerated, sometimes by section or even destruction along 1 cm. or more of

its course. Paralysis secondary to compression heals rapidly after the correct carrying out of a mastoid opening.

A nerve which has been simply contused or partially lacerated also shows, after the mastoid opening, signs of functional restoration which are of good omen.

Complete section, in which it is impossible to predict the anatomical relation of the two fragments, has a much more serious prognosis. Prof. Moure has proposed ¹ systematic exposure of the nerve in the Fallopian canal, immediately above and behind the fenestra ovalis, after an extensive opening of the petro-mastoid region; he then follows it along its whole mastoid course, and if he finds it divided he sutures it. He has carried out this delicate operation several times; the results have seemed to him very encouraging; it will be very interesting to know the distant future histories of these cases.

Ankylosis of the maxilla.—We must never forget to watch the movements of the temporo-maxillary articulation. The slightest tendency to trismus calls urgently for early mobilisation, that is to say, gradual separation by means of suitably adapted mouth-props. Neglect of this part of the treatment dooms the patient to an extremely inconvenient infirmity.

Old-standing ankylosis is amenable to surgical treatment. Morestin gives the preference to Le Dentu's operation; we shall not describe it; we should be going outside our subject.

Injury of the lateral sinus.—Surgeons cannot have seen many injuries of the sinus; the wounded men die before reaching the operation hall; a

¹ *La Presse Médicale*, 1916.

temporary spontaneous hæmostasis does not, however, appear impossible to us under certain conditions. Laceration of the vessel sometimes occurs in the course of trephining the mastoid process, particularly when the bone is splintered. The course of action should be the same in both cases. These venous hæmorrhages are very easily arrested by plugging. A wound of the lateral sinus is not dangerous on account of the hæmorrhage when this is treated in time, but on account of the liability to infection through the blood.

A hasty rough first dressing is effected immediately with gauze that serves to staunch the blood during the operation; the assistant holds this dressing *in situ*; the surgeon picks out a strip of aseptic or iodoform gauze; he takes hold of the end—which should be fairly narrow—with straight or bent forceps without teeth but slightly roughened; the assistant slowly raises the temporary dressing and the surgeon immediately places his gauze on the sinus—as much as possible on the sinus, not in the cavity; he packs it and above it he places another plug; he continues his operation towards the tip, towards the upper part, or towards the meatus, wherever he has to get to and where he finds access. The operation must be quickly brought to a close; an open sinus must not be allowed to remain exposed to the entrance of splinters of bone and an infected focus.

The exterior dressing must be changed the next day; on the following one all the strips which plug the mastoid cavity are removed, being gently loosened by means of peroxide of hydrogen. The strip in the sinus above remains *in situ*. The dressing is repeated each day. On the fourth day we begin to pull on the strip in the sinus, after detaching it, and

we cut away with scissors whatever part of it comes easily and without hæmorrhage. On the sixth day the whole of it can generally be removed in this way.

The temperature is taken regularly each day, note being made of the slightest rigor which would call for immediate removal of the strip of gauze in the sinus and its replacement.

We cannot here deal with thrombo-phlebitis of the lateral sinus and the consequent pyæmia, without getting beyond the limits of this work. We will refer the reader to the classical treatises on the subject.

Injuries of the dura-mater.—Exposure and even rupture of the dura-mater in a non-infected or early disinfected area, do not necessitate a very bad prognosis. Care should be taken not to mobilise the edges of a meningeal wound and thus to avoid breaking down the very useful adhesions; what is required above everything is to search for and remove all splinters of bone and all foreign bodies in the neighbourhood; death may supervene on account of a microscopic chip of bone slipping between the dura-mater and the roof of the antrum; we must, further, not be afraid to lay bare this membrane sufficiently to enable us to feel sure that nothing remains between it and the bone which it lines.

Suppurative meningitis and abscess of the brain must be treated according to the recognised methods; they may sometimes be cured, especially abscesses. The prognosis of diffuse encephalitis is, on the contrary, fatal.

THIRD PART

WAR DEAFNESS

CHAPTER I

LABYRINTHINE CONCUSSION FROM DIRECT VIOLENCE TO THE CRANIUM

Labyrinthine deafness secondary to a blow on the cranium is well known to us from the study of fractures of the petrous bone ; the war has taught us nothing essential on this subject.

Etiology.—The shock may be due to a fall on the head or to a blow from a blunt instrument such as a stone or billet, as may take place on the falling-in of a dug-out or trench.

The usual cause, however, is a projectile—a bullet or splinter from a shell—striking the cranium perpendicularly or tangentially to its surface.

The degree of injury to the labyrinth depends on two conditions :—1st, the speed and size of the projectile ; 2nd, the spot at which it strikes the cranium or the framework of the face.

A blow on the mastoid region is the most formidable as regards the internal ear.

Lannois and Chavanne, in their statistics, report that out of 38 injuries of the mastoid region, the hearing was destroyed in 94 per cent. of cases—totally in 73 per cent., and partially in 21 per cent. Our own statistics (Bourgeois), which are registered as 23 cases of cranial injuries by projectiles of war, 15 of which were mastoid wounds, give us for this last variety 9 cases of total labyrinthine deafness, say 60 per cent., and 5 cases of partial deafness, 33 per cent., making a total of 93 per cent.

The projectile, though of the same force, is much less harmful when it strikes at some distance from the ear.

In injuries of the temporo-maxillary region, our statistics (three cases) give us one-third total deafness, one-third partial deafness.

With regard to other regions of the cranium, namely, occipital and temporo-parietal, injury to the labyrinth is again frequent (Chatelin); it is rarer in traumatisms of the frontal region (Lannois and Chavanne).

Finally, there seems to be no labyrinthine lesion when the projectile only involves the soft parts, particularly in wounds of the external auditory membranous meatus.

Pathological anatomy.—**Seat of the lesion.**—As a rule in cranial injuries from projectiles of war, the labyrinthine lesion is unilateral and on the same side as the injury; in only 2 cases out of 23 was it found to be bilateral but less marked on one side than the other.

The anterior (cochlear) labyrinth was alone affected, with total or partial unilateral deafness, ten times.

In five other cases the cochlea and the vestibular

apparatus were affected simultaneously—four exactly alike with total deafness and loss of excitability of the vestibular nerve, one with total deafness and hypo-excitability. Finally, in two cases there was an inverse dissociation, namely preservation of the anterior labyrinth with impairment of the posterior, total in one case and partial in the other.

Nature of the lesion.—The nature of the lesion very often escapes us for want of direct examinations, autopsies and histological researches.

According to pre-war writings, particularly those of Halphen¹ and Le Mée, three forms of pathological involvement may be observed :—

(a) Complete destruction of the internal ear by the projectile itself; this is rare, the labyrinth being deeply situated.

(b) Irradiation of a fracture of the mastoid process or the base of the skull to the osseous labyrinth. If the *fracture is macroscopic*, the perpendicular tract in the direction of the petrous bone involves the vestibule, the semi-circular canals, the cochlea and often the aqueduct of Fallopius. The membranous labyrinth is ruptured, filled with blood, the organ of Corti is destroyed and the facial nerve paralysed.

If the *fracture is microscopic*, its principal seat is at the level of the inter-fenestral region, the promontory and the beginning of the scala tympani. It is accompanied by profuse extra- and intra-labyrinthine hæmorrhage with impairment of the epithelium and nerve.

(c) Lesions of the membranous labyrinth without injury to the bone; “ hæmorrhages into

¹ HALPHEN, *Lésions traumatiques de l'oreille interne*. Thèse, Paris, 1910.

the narrow canals, into the region of the fenestra rotunda and into the nerve trunks; fissure of the inferior part of the vestibule but preservation of the osseous capsule properly so called." The acoustic lesions are generally much more marked than the vestibular ones.

Course.—The fracture becomes consolidated; the hæmorrhage becomes absorbed; suppuration rarely takes place. Later on, Nager's chronic obliterating internal otitis shows itself, "the labyrinth is invaded by fibro-osseous tissue; the membranous vestibule is out of shape and unrecognisable; the auditory cells can no longer be differentiated; the cochlear nerve degenerates."

Pathogenesis.—When the existence of a fracture of the osseous capsule of the labyrinth can be made out macroscopically, the mechanism of the labyrinthine lesion is evident, namely that it is the result of direct violence from a projectile against the labyrinthine wall or of the irradiation of a fracture of the vault to the base of the skull.

The problem commences, however, when no macroscopic lesion of the osseous capsule is to be found.

The existence of a deeply-seated lesion in the membranous labyrinth cannot be doubted when all the clinical signs of definite organic labyrinthine deafness are present. Can this membranous lesion exist without an osseous lesion? Le Mée does not believe so. According to him the real cause of the membranous lesion is a microscopic fracture of the petrous bone; "it is that and not the concussion which gives rise to the labyrinthine hæmorrhage." This is also Toubert's opinion.

Lannois and Chavanne, without rejecting the

microscopic fracture theory, admit the possibility of labyrinthine concussion and membranous lesions without involvement of the bone :—" We must admit lesions of the organ of Corti analogous to ruptures of the choroid in wounded men in whom the projectiles have passed at some distance from the eye."

We believe, in regard to a microscopic fracture, that it may be the chief cause of the labyrinthine hæmorrhages after blows on the cranium from blunt slowly-moving objects, the action of which is prolonged in some way ; the bone gives way under the slow continuous pressure ; the depressions are disconnected.

But we must acknowledge the possibility of membranous lesions, either alone or associated with an osseous lesion. It seems to us that a projectile moving at great speed and with an extremely short action on the cranium must, on account of the rapid shock, bring about an intense vibratory movement which is transmitted by bone-conduction (as with a tuning-fork on the vertex) to the whole of the solid mass of the skull and extends to the labyrinthine liquid, the exaggerated displacement of which brings about rupture of the fragile endings of the nerve of hearing or of the fine capillaries.

Thus we have a labyrinthine deafness by the conduction of an exaggerated vibratory movement through the solid bone, just as occurs by air-conduction, as we shall see in the following chapter.

And if the first mode of transmission is really more perfect than the second, the seriousness of labyrinthine lesions in deafness caused by direct violence from a projectile on the cranium will be understood.

We must, however, admit that the absence of precise reports allows of hypotheses only.

Symptoms.—The wounded man usually becomes comatose immediately after the accident.

The labyrinthine symptoms may be made out some hours or days later, when consciousness has returned; they consist of total or partial deafness, subjective noises, vertigo, nausea, vomiting, spontaneous nystagmus, this combination of symptoms not being always complete.

The aurist only sees in the early stage, among these wounded men, those in whom the wound involves the auriculo-mastoid region; a preceding chapter has been devoted to this subject.

He examines the others later when the wound has become cicatrised and it is necessary to determine the nature and degree of the aural disturbances.

He first of all looks at the auricle; there is no visible lesion if the injury has not involved it; he then examines the injury produced by the missile in order to make out whether the bone has been touched.

A study of the hearing and the equilibrium reveals either an isolated or associated affection, total or partial, of the anterior and posterior labyrinths.

Auditory disturbances are by far the most frequent and the most important from the practical point of view. The lesions are happily unilateral in the great majority of cases. We have observed two cases of bilateral deafness (total on the right side and partial on the left) which had been produced by a bullet entering by the left temporo-maxillary region, its exit being at the level of the ascending branch of the right inferior maxilla.

Unilateral deafness is more often total than partial, nine times against seven (Bourgeois); by total

deafness is to be understood the absence of all auditory perception; concussion by direct violence differs in this respect from that from explosion where the abolition of the function is generally less complete. In the former the affected ear hears no sound; if such does not appear to be the case it is because in reality the hearing of the other ear has not been eliminated; this question will be considered in detail in the chapter on medical reports in connection with the erroneous perception of sharp sounds by the deaf ear, with also the "false" negative Rinne of Lermoyez and Hautant.

In the type described as partial deafness, the dulness of hearing has always appeared to us to be marked, the whispered voice being generally perceived only on contact. The different hearing tests bear witness to the labyrinthine origin of the lesion. In order to avoid useless repetition, we shall ask the reader to refer to the following chapter and to the one on medical reports.

Marked symptoms of disturbance of equilibration are frequent enough during the first days following the injury; they become less later on; certain injured men, however, complain of vertiginous symptoms when examined for medical report; they show a certain hesitation on walking, which becomes more apparent when the eyes are closed; there may also be noted a tendency to lean laterally towards the affected side or to fall backwards when in Romberg's position.

The vestibular tests furnish some interesting information; they show complete loss of excitability of the semi-circular canals to irrigation with cold water, or a marked hypo-excitability. The galvanic

current passed from one ear to the other shows either loss of vestibular excitability, hypo-excitability or an anomalous sense of balance, there being a tendency to fall backwards or to the side of the affected ear, whatever be the direction of the current.

Course. Prognosis.—Our previous knowledge concerning fractures of the petrous bone does not hold out any hope as to the future of these total deafnesses. They are incurable. Certain partial deafnesses are susceptible of some amelioration. We do not as yet possess any exact data on this point. The equilibrial disturbances disappear in the long run, even when the tests show a persistence of the loss of vestibular excitability; the opposite internal ear exercises a compensatory function; all the same, for some time sudden movements of the head may readily provoke dizziness; this, however, is of no importance; the vertiginous symptoms “generally decrease by degrees and finish by disappearing completely in less than a year after the injury” (Chatelin).

Diagnosis.—A man receives a violent blow on the head; he becomes deaf after it; it is not difficult to establish a diagnosis of labyrinthine concussion.

A much more difficult question arises in connection with the many with wounds of the skull who complain of vertigo and giddiness and who are referred to us in order that we may find out if these symptoms are the result of an aural lesion. For them a careful examination of the two functions of the internal ear is required.

The ascertainment of normal vestibular reactions implies that the labyrinths are unaffected.

The existence of a diminution of the perception of sounds by bone-conduction associated with hypo-

excitability of the semi-circular canals confirms the diagnosis of labyrinthine concussion, and the same may be said of a decided unilateral hypo-excitability even if unaccompanied by deafness.

But can it be said that the vertigo is certainly of aural origin when merely an anomaly, more or less pronounced, of the vestibular reflexes of the two sides is ascertainable? We do not believe so. These patients present, in addition, undeniable nervous lesions, and we do not know in which part of the reflex arc the cause of the observed phenomena is situated. The detection of these disturbances is equally interesting for the purpose of corroborating purely subjective phenomena. We must not forget, before deciding, that vestibular excitability varies greatly in different subjects, independently of any morbid condition.

The symptomatology of cerebellar and labyrinthine affections is similar in many points; the same injury may involve one or other organ or the two together. The result is that in the presence of certain injuries with equilibrial disturbances we have to ask ourselves whether the lesion is labyrinthine, cerebellar or a combination of the two; the cerebellum may suffer directly from an injury to the occipital region; it may be contused by a *contre-coup* from a blow on the vertex; either traumatism is equally capable of provoking labyrinthine concussion.

The labyrinth is alone affected.—The hearing is then generally diminished or abolished. The objective disturbances in walking are relatively less accentuated than the vertiginous sensations. The patient staggers on walking and he separates his legs to enlarge his base of support. He often veers to one side, namely

towards the affected one. The same lateral swaying is observed when he is in the upright position, standing on both feet or on one alone, or he may tend to fall backwards.

These disturbances are wanting in the milder cases, but they become more apparent if the eyes are closed. The sensation of falling is modified by the position of the head; if a man who has a tendency to fall towards the left has his head turned 90 degrees towards that side, he will have an inclination to fall backwards.

The rotation and caloric tests show hypo-excitability or inexcitability of the semi-circular canals, that is to say, nystagmus cannot be induced, or it takes long to appear and disappears quickly; at the same time the deviation of the limbs and the trunk, the direction of which is opposite to that of the nystagmus,¹ is less marked or is totally absent.

Babinski's galvanic test gives the results previously mentioned.

The cerebellum is alone affected.—The hearing is normal. The vertiginous symptoms are relatively less than the objective disturbances of co-ordination. These latter should be sought for in the upper and lower limbs²; a study should be made of the equilibrium during walking and in standing upright, of the sudden fall of a single part, disorderly movements, adiadokokinesis, asynergy, impairment of writing and speech, all of which symptoms have been minutely described by Babinski. Closing the eyes does not increase the loss of equilibration. Romberg's sign

¹ See page 193.

² See CHATELIN and DE MARTEL, *Blessures du crâne et du cerveau* (Collection Horizon), p. 140 and following pages.

is negative. Variations in the position of the head do not modify the sensation of falling.

Barany's nystagmic reflexes are normal, but—this is an important point—excitation of the vestibule no longer produces the movements of deviation of the limbs; for Barany has shown that this deviation is brought about by the intermediary of the cerebellum, and he has even localised cerebellar lesions by the absence alone of the provoked deviation of the upper and lower limbs.

The labyrinth and cerebellum are both affected.—The clinical picture is that of destruction of the labyrinth, to which is added the special motor disturbances of a cerebellar syndrome.

Treatment. Course to follow.—There is no therapeutic indication for these labyrinthine concussions. The total deafness is incurable, but it inconveniences the wounded man very little on account of its unilateral nature. The question of re-education or lip-reading does not arise.

The vertiginous disturbances disappear spontaneously in the course of time.

From the military point of view total unilateral deafness calls for transference to the auxiliary service, and partial unilateral deafness for maintenance in the combatant service, provided that the other ear is sufficiently good.

Conclusions as to the vertiginous disturbances must only be provisional, by reason of the favourable prognosis.

CHAPTER II

LABYRINTHINE CONCUSSION FROM EXPLOSIONS

The question of labyrinthine concussions produced by a violent noise or a sudden and considerable change of atmospheric pressure is not an entirely new one. We knew of the deafness of artillerymen and workers in caissons of which a number were observed during the building of the Paris Metropolitan Underground Railway, and which were mostly simple in nature; a short time before the war Siebenmann studied experimentally the lesions of the organ of Corti produced in guinea-pigs by intense noise.

The amount of deafness produced by the explosion of large artillery projectiles was already considerable at the end of 1914. When the special otological centres were opened at the end of the winter of 1915, they received a good number of extremely deaf men without counting those who had already been discharged.

The first idea of the majority of aurists was to attribute these deafnesses to involvement of the internal ear and consequently to look upon them as incurable. A careful examination of these patients and the course of their infirmity led to a reconsideration of this judgment, and a new tendency arose, that of

distinguishing a large number among these deafnesses as being purely functional.

Sicard published in the *Paris Médical* a series of singularly demonstrative observations of patients examined in collaboration with Bellin; Brindel announced in his reports that he had brought about many cures by purely moral means; we ourselves called attention to the persistence of the “*assourdisseur*” reflex and, later on, sham lip-reading. Finally, Gault, who came, somewhat later, as principal of the Centre, was struck by the number of cases of extreme deafness that he found there, whereas at the Front he only found one deaf man in 600 who had their ears examined immediately after the bombardments; he then experimented with the cochleo-palpebral reflex and came to the conclusion that a number of the cases of deafness were of “*psychical*” nature.

We do not profess to have written a complete history of the subject; we have not the means of doing so, and we hope that the authors whom we may have omitted to mention will pardon us.

Whatever was the cause, the evolution came into operation, more or less slowly, among first one and then another. The result was shown by a change for the better in the number of applications for discharge and even pensions:—“The number of wounded complaining of deafness is considerable. Frequent as applications for pensions were at the beginning of hostilities, so they have equally become infrequent, without, on the other hand, the number of cases examined being less.”¹

Etiology.—Frequency.—There are no statistics to

¹ DUCCO and BLUM, *Guide du médecin dans les expertises médico-légales* (Collection Horizon), p. 111.

permit of a distinction between organic labyrinthine deafness and functional deafness. This is of no importance, for all functional deafness is, at its origin, real and organic; simulation and pithiatism appear later; simulators and hysterical men are cases of cured deafness who refuse to recognise the return of their hearing power.

The frequency of concussion-deafness is therefore great if the curable and improved cases are included among them; the severe cases are rare. We have observed 327 cases of concussion from detonation out of 6,171 patients or injured men of all sorts examined at our Centre up to October, 1916, that is, nearly as many as the cases of traumatic median otitis. In February, 1916, Lannois and Chavanne saw 1,000 cases of war-deafness, of which 262 were of pure labyrinthine concussion.

Predisposing local causes.—We are not able at the moment to establish, by personally made statistics, the influence of former lesions of the ear. It is natural to suppose that a large old tympanic perforation deprives the labyrinth of its natural protective screen. Tubo-tympanic catarrhs, counteracting good ventilation of the drum, favour the action of sudden differences of pressure on the internal ear; attention has for a long time been drawn to this point in connection with the action of pressure in the caissons and in mountain sickness. It is natural that an already defective internal ear should be more fragile.

Out of 1,000 cases of deafness Lannois counted 189 cases of otorrhœa, of which 57 per cent. were considered unfit for combatant service after a period in the trenches; and 134 cases of sclerosis, of which 48 per cent. would have to be sent to the "Auxiliary"

service, but it is not possible to make allowance for initial error of enrolment and aggravation due to faulty hygiene, humidity and want of attention.

Vicarious rôle of rupture of the tympanic membrane.—We have explained in a preceding chapter that rupture of the tympanic membrane produced by displacement of the air, saves the cochlea ; this protective action has been admitted by all authors. Its importance, however, must not be exaggerated ; we have seen more than one case of marked labyrinthine deafness occurring in spite of the rupture of the membrane.

Determining causes.—The violent displacement of the air acts on the tympanic membrane by a mechanism which we have described in connection with injuries to the middle ear. The chain of ossicles transmits the blow to the fenestra ovalis and by its intermediary to the endolymph, and from this changes take place in the internal ear on the nature of which we are unfortunately reduced to hypotheses.

Pathological anatomy.—We do not indeed know the results of an autopsy on a single deaf injured man. Prenant and Castex have, however, made some extremely interesting experiments on six rabbits and ten guinea-pigs which they rendered deaf by detonations of “ 155 short,” “ 20 long ” and a “ 75.” We give here their results, in their own words.¹

“The most frequent and most characteristic histological lesions were the following :—

“(1) Dislocation of the different parts of the *ductus cochlearis*, always more marked at the first and second turns of the spiral. It is the organ of Corti itself

¹ *Paris Médical*, 10 March, 1917, analysed in the *Presse Médicale*, 6 April, 1917.

which has very often undergone great destruction (dislocated pillars, displaced external acoustic cells, Hensen's cells disturbed and even displaced). The hairs of the acoustic cells remain visible.

"(2) Several times in the scala tympani there was found considerable effusion of blood of recent occurrence, due probably to rupture of the very numerous vessels which are situated in the wall of the scala tympani.

"(3) There were noted many times on the first turn of the spiral an actual atrophy of the organ of Corti and of all the structures on the cochlear surface of the basilar membrane. The latter has the appearance of being covered with indifferent cubical cells, presenting no sensorial character. But this degeneration may also result from some injurious immobilising condition.

"(4) Examination of the spiral ganglion of Rosenthal has shown the ganglionic cells to be more shrivelled than normal.

"(5) In one case there was degeneration of the cochlear nerve in its central fibres connecting the ganglion to the brain; these fibres were demyelinated and the degeneration followed a clearly ascending course.

"(6) Integrity of the organs of the static sense noted in every case."

This integrity of the vestibule is worthy of remark; it confirms the results of clinical observation in human beings in showing that the vestibular reflexes, though often affected, are seldom abolished, and that however intense the auditory paralysis may be, the vestibular apparatus is not functionally destroyed. This immunisation of the equilibrial apparatus shows the

contrast between concussion from explosion and concussion from direct violence in which the vestibule is more often and more deeply involved. Cell and nerve lesions and hæmorrhages explain the deafness perfectly well; they correspond to severe war deafness. Slighter and more ephemeral lesions (minute hæmorrhages and intra-cellular molecular changes?) must be kept in mind in order to explain the cases of transient deafness and the attenuated forms.

Symptoms

Ephemeral deafness.—An explosion close at hand causes a transient deafness. It is a common occurrence, and this deafness which has been attributed to a nervous exhaustion secondary to a loud sonorous sensation, hardly deserves the name of labyrinthine concussion, if it does not approach by insensible degrees to more lasting deafness.

Whatever it may be, we describe as “ephemeral deafness” the very slight degrees of concussion where symptoms only last a few hours or days and disappear without leaving any appreciable traces. It would not be correct to affirm that no real residuum remains, since a repetition of the same accident may in time produce deafness.

The deafness, or rather the slight dulness, shows itself as a disagreeable feeling of tension in the ear accompanied by buzzings or whistling; the deafness, properly so called, is not very great, and the man, if he is energetic, continues to understand conversation in spite of the subjective noises. The discomfort lasts for a few hours, after which all is again in order.

At the most the deafness remains a few days,

accompanied by violent buzzing. We have not seen it at the time, and on this subject we have only the retrospective information furnished by the injured men, but the unanimity of their statements leads us to admit their veracity, while taking into consideration the possibility of exaggeration.

A fairly large number amongst them when examined for unilateral lesions have stated that they were entirely deaf in both ears for a few hours or a few days; others presenting symptoms of a middle ear lesion only at the time of the examination complained of very great initial deafness.

There is thus reason to accept a form of labyrinthine concussion involving an ephemeral deafness, ranging from simple dulness to a very notable diminution of hearing power.

Partial deafness.—Partial deafness is very common. The patient has been totally deaf or very deaf during the first few days; he still has marked deafness at the end of some months; any possible amelioration is only to be obtained after some time; complete cure is probably impossible.

Both ears may be affected but very unequally; one of them may even have completely escaped.

This deafness presents the labyrinthine characteristics and answers to the following scheme:—

A watch on the bone is not perceived; by the air it is only heard at a few centimetres. Weber is lateralised to the good ear, Schwabach diminished and Rinne positive.

The loud voice is only heard at 2 or 3 metres, or still less; the whispered voice is not heard at all or only on contact.

The upper limit of hearing for high-pitched tones

is more or less lowered; a considerable lowering indicates an unfavourable prognosis (Lermoyez and Lannois). The study of the cochlear reflexes ¹ is of the greatest importance as much as regards prognosis as diagnosis.

An abolition or a marked diminution of the reflexes signifies a severe affection of the labyrinth and organic deafness with uncertain prognosis.

Preservation of the reflexes implies a relative functional integrity of the internal ear; should it coincide with an apparently marked deafness, the latter must be looked upon as partly or totally a functional disturbance, hysterical or simulated.

The two cochlear reflexes are, firstly, the "assourdisseur" reflex, and secondly, the cochleo-palpebral. They are considered in detail later on. The information they give is what would be expected in the partial labyrinthine deafnesses with which we are concerned at this moment.

The cochleo-palpebral reflex is diminished, that is to say, a much stronger noise than the ordinary one is necessary to provoke winking. The application of the "noise-machine" to the deafer ear does not produce raising of the voice. When applied to the good or the better ear notable voice-raising is produced, but when applied to both ears at the same time the voice-raising is more marked than when applied to the good ear alone, proving that the worse one has a certain amount of hearing-power in it.

The *disturbances of equilibrium* occupy a very secondary place as compared with the deafness.

Some injured men narrate that they were unable to reach the aid-post by themselves, that they

¹ See "Medical Reports."

staggered like drunken men and vomited for one or two days; others recall simply a vertiginous condition and uncomfortable nausea. As a matter of fact the onset escapes our notice more often than not, for the patient loses consciousness at the time of the accident, or, if he was partly conscious, he suffers more or less from cerebral concussion and is in an emotional state.

When examined some weeks or some months after his injury, the man who has been concussed generally presents no manifest equilibrial disturbances; he walks normally without his legs being abnormally wide apart and without staggering; he complains sometimes of sensations of dizziness, but not of acute vertiginous crises accompanied by falling down. Spontaneous nystagmus is exceptional.

It does not follow, however, that the equilibrial apparatus is always normal; a careful examination often enough reveals anomalies of equilibrium in walking and standing upright with the eyes shut; the patient sometimes shows a tendency to fall when standing with the feet together and the eyes shut, or still more when standing on one foot alone; he has generally a tendency to fall either backwards or more often to the side of the deafer ear.

Still more demonstrative is the test of walking backwards and forwards with the eyes closed, as we shall describe later on according to Babinski and Weil.¹ This test, the most delicate of all, reveals the spontaneous tendency to unilateral deviation when this tendency exists in the feeblest degree; the direction of the deviation is nearly always to the side of the affected ear. The walk, on the contrary,

¹ See page 208.

appears hesitating, without deviation either to the right or to the left, when the subject is directed backwards in the upright position.

The vestibular reactions are normal in a great number of cases, but certain anomalies will be detected if the tests are practised with care in men in whom these disturbances in walking exist. These are pre-eminently variable, and there is no apparent connection between the character of the deafness and the results of the functional examination of the labyrinth.

Barany's tests only very occasionally show caloric *inexcitability* of the labyrinth, but more often hyper-excitability, that is to say, irrigation with cold water produces nystagmus quickly, the vertiginous symptoms being very marked; still more often, however, the semi-circular canals are hypo-excitabile. We have twice seen disturbances of equilibrium following irrigation with cold water operating always in the same direction as the ear irrigated; galvanic deviation took place also in the same direction as that on which the positive pole was placed.

We have never seen galvanic inexcitability, but sometimes patients have reacted to an abnormally feeble current; sometimes they could bear an abnormally strong one. Some swayed backwards, others to the side of the affected ear, whatever the direction of the current. In short, the results absolutely conform to Babinski's publications.

We repeat that these pathological symptoms revealed by systematic examination do not necessarily testify to a disorder of function of the vestibular apparatus of any practical importance; neither do they give any information as to the seriousness of

the deafness ; it is interesting to note them as objective signs of involvement of the internal ear.

Tinnitus.—Subjective noises trouble a great many patients ; they consist of buzzing and whistling ; they often last several months and the fact of their existence cannot be controlled.

Auditory hyperæsthesia.—Although deaf, the injured men dread noise ; a sudden loud sound is painful to them ; they are found to be unable to work in factories. This symptom is almost invariably present and nearly all the men wear cotton-wool in their ears. After a time they must be encouraged to overcome this exaggerated sensitiveness, but this symptom shows the danger of certain noisy modes of auditory re-education.

Headache.—A fair number of patients with labyrinthine concussion complain of headache, not very violent, but heavy and persistent. It presents the same characteristics as the headache observed by Chatelin in the subjects of injuries of the cranium, and, as a matter of fact, this author wonders if such headache may not be caused by concussion of the labyrinth. Disturbances of the venous circulation by thrombosis of the sinus, also brought forward by Chatelin, could not be considered a cause ; obliteration of the lateral sinus, which is often observed by aurists, has never produced anything of this kind.

These partial deafnesses from explosion become aggravated or ameliorated, or they remain stationary.

Fortunately aggravation is exceptionally rare. Lannois, according to Lermoyez, has noted progressive loss of the remnant of hearing in 3 out of 1,000 deafened men. One of us has published the case of

a concussed man who was suddenly seized with a severe attack of Menière's vertigo thirty-six hours after a lumbar puncture and two and a half months after the concussion. The hearing of one of the ears disappeared completely. Everything pointed to a hæmorrhage in the internal ear. Another patient, totally deaf in one ear and very dull of hearing in the other, lost the use of the latter in two or three days, whilst he complained at the same time of headache and giddiness.

Amelioration is fortunately much more frequent. Lannois and Chavanne have obtained 24 per cent. cures in a month, 22 per cent. in two months, 19 per cent. in three months, 12 per cent. in four months, the others varying between five and nine months; by cure must be understood the possibility of taking up a normal life and not complete functional restitution.

Total or almost total deafness.—The onset is identical with that of partial deafness, the hearing remaining lost in one ear or both.

Total bilateral deafness is fortunately very exceptional. Total unilateral deafness is, on the contrary, fairly frequent; we have found it in 6 out of a series of 30 cases of concussion. The deaf ear is the one which was turned towards the projectile at the time of the accident.

The ear perceives no sound; all the hearing-tests are negative; this is, however, rare; more often the shouted voice is heard on close contact and the low-toned tuning-forks during a few seconds.

No noise provokes winking when the good ear is closed. The application of the noise-machine to the affected ear produces no modification of the voice;

when applied to the good ear there is marked voice-raising; when applied simultaneously to the two ears no further increase of voice-raising is added to this.

The future course of a deafness which presents such marked signs to Lombard's test does not seem to us to promise rapid or any great improvement.

Vestibular symptoms, headache and tinnitus do not differ from those described in regard to the preceding form.

Prognosis.—It is premature as yet to predict the future in this form of deafness. A longer period is necessary before we can eliminate with more confidence the share taken by purely functional disturbances.

It is recognised, however, that these deafnesses of warfare in the severe bilateral form are exceptional, and that the others improve frequently and very decidedly.

Diagnosis

Positive diagnosis.—The positive diagnosis of a labyrinthine deafness from concussion is established from the history and the results of a complete examination bearing at the same time on the hearing and the equilibration.

If the tympanic membrane and middle ear are found to be sound, the probability is that the deafness is of labyrinthine origin, but the existence of a perforation does not eliminate *à priori* the possibility of concussion of the internal ear.

We shall not revert to the characteristics of labyrinthine deafness which is always severe and which is accompanied by an abolition or diminution of the

cochlear reflexes and involvement of the two modes of transmission of sound, *i.e.* the osseous and the aerial.

Disturbances of equilibrium are not always present, but the functional reactions of the semi-circular canals should always be carefully examined by the various tests, when anomalies will often be found. Mild disturbances of the vestibular apparatus do not absolutely prove the reality or in particular the extent of labyrinthine deafness, but they constitute presumptive evidence and show that the internal ear has been touched at least in one of its parts.

Diagnosis by lumbar puncture.—It has been said that lumbar puncture constitutes an indispensable element in the diagnosis of deafnesses from concussion. There must, however, be a clearer understanding on this matter.

The labyrinthine lesion does not of itself cause any appreciable modification in the cerebro-spinal fluid. A normal condition of the latter does not in any way signify that the labyrinth is not affected.

Lumbar puncture reveals either hypertension of the fluid or hyper-albuminosis in cases of organic concussion from explosion, but by cases of organic concussion must be understood concussion with lesions of the nervous system, not of the labyrinth. These pathological changes in the cerebro-spinal fluid indicate an injury of the cerebro-spinal axis, but by no means traumatism of the internal ear. It may be advanced that with an encephalic lesion there must be a lesion of the labyrinth as well. This presumption is not a proof and must not be accepted as such; hystero-organic associations are so frequent that the organic or functional character of each symptom

rests on the analysis of its own characteristics; the injured man may quite well have cerebro-spinal hypertension and purely hysterical motor, sensory and aural disturbances. No neurologist will deny this.

But it may again be said that hypertension and hyper-albuminosis indicate organic lesions of the central nervous system and the deafness must be attributed to this; we shall see, on the contrary, that the existence of these cerebral deafnesses is by no means demonstrated.

Finally, the protagonists of lumbar puncture ask us to accept that an injured man who has the recognised anomalies in his cerebro-spinal fluid is not entirely a simulator, that he is really ill and that the systematic practice of this exploration constitutes for the injured man a valuable guarantee from this point of view. We are absolutely agreed with regard to this principle. But why not send all these patients to the neurologist for completion of the observation instead of performing lumbar puncture ourselves? Supposing we ascertain anomalies in the fluid, we do well then to refer our patient to a neurologist; it is scarcely probable that he will be satisfied with our examination; he will perform a fresh puncture and we do not think such a repetition good either for the wounded man or for the medical report.

To resume, lumbar puncture which renders such valuable service to the aurist for the treatment of certain vertigos and for the diagnosis and treatment of meningitis, does not give any information as to the nature of a labyrinthine deafness from explosion; it only reveals the lesions of the central nervous system; it is better for the aurist to depend entirely

on his aural examination in order to appreciate the extent and the anatomical causes of the deafness, and that he should leave the lumbar puncture to his neurological confrère.

Differential diagnosis.—The distinction from deafness of median otitic origin is familiar to us; we will not go over it again.

The injured men have a habit of attributing all their aural affections to recent events. We must know how to question them. We have thus elicited several times that total unilateral deafness, falsely attributed to an explosion, in reality proceeded from old fracture of the petrous bone long before the present campaign.

We have also recognised a syphilitic origin for a labyrinthine deafness attributed by the patient quite in good faith to a concussion; certain peculiarities in the onset and course put us on our guard and a complete examination of the patient set us on the right path. Lumbar puncture has furnished us with valuable information in similar cases; it would under these circumstances be quite within our right and it would be our duty to practise it in order to effect a cytological examination of the fluid and the Wassermann reaction.

These facts show how necessary it is to examine and interrogate the wounded men with care and not to accept the truth of their assertions straight off.

Apart from organic lesions of the labyrinth, morbid changes in the auditory nerve tracts and centres may give rise to deafness with an identical acoumetric formula; such deafness always arises from a lesion of the apparatus of perception. The diagnosis is based not on the characteristics of the deafness,

but on the nerve symptoms which accompany the deafness and indicate an anatomical lesion of a particular territory. We shall devote the following chapter to this type, but we may say now that no one has ever demonstrated the existence of deafness attributable to nervous concussion from an explosion; the aurists who have cited its existence have argued from its analogy to other paralytic or sensory disturbances noted by other authors, but they have not brought forward anatomical arguments or clinical proofs, by which we mean a statement of associated symptoms proving the existence of a focal lesion. As for the neurologists, such as Chatelin, who has seen 5,000 wounded or concussed soldiers, they only recognise organic labyrinthine deafness and functional deafness, hysterical or simulated.

There remains finally the diagnosis between labyrinthine and functional deafness. It is most important, as many mistakes have been made on this subject. We will discuss it at length in the chapters devoted to hysteria, simulation and medical reports.

It is based especially on the ascertainment of the absence or diminution of the reflexes in cases of actual lesion, and of preservation of the reflexes in the case of hysteria.

This principle of the reflexes has rendered the differentiation easy and certain. Where the diagnosis is difficult is in the mixed cases where there is voluntary or unconscious exaggeration; hence the necessity for lengthy and minute tests which we shall describe in the chapter on Medical Reports.

Treatment.—*Early treatment.*—Cases of ear concussion, like all cases of concussion, must at first

be given rest and quiet. They experience fear of noise which makes a disagreeable impression on them ; they all wear cotton-wool in their ears and they must be allowed to do so for a time.

Rest is sufficient in the majority of cases ; it is, however, found necessary to administer sedatives such as bromide as well as antipyrin to combat the headache and obstinate insomnia.

Does the deafness call for medicinal treatment ? To prescribe iodide of potassium, as some would recommend, is to administer drugs for the pleasure of doing so. What is the use ? Paul Laurens is in favour of subcutaneous injections of pilocarpine which constitute the classical treatment of recent labyrinthine deafness in time of peace. The experience of this author is based on the results in a small number of patients ; the question is worthy of being taken up again and elucidated.

Every case of concussion is a possible " pithiatic " ; our mode of examination, our attitude towards him, our reflections, our diagnosis must be guided by the necessity of avoiding all suggestion capable of making him believe that he is deafer than he really is. It is, in effect, exceptional for the deafness not to improve spontaneously after a few days, at least in one ear.

Later treatment.—The injury is to a certain extent " consolidated " ; the spontaneous amelioration of the first few days has gone as far as can be expected of it.

The phenomena of headache, hyperacusis, giddiness have diminished or disappeared. The degree of deafness is not definitely unalterable ; we know that spontaneous improvement is still possible, but

very slowly after many months; we have now to decide as to our course of action in regard to the injured man. There are several contingencies to be considered.

Total unilateral deafness calls for an application for transfer to the auxiliary service.

Partial unilateral deafness is compatible with remaining in the combatant service and return to the regiment, provided the hearing of the other ear is sufficiently good.

Total or almost total bilateral deafness is exceptional, as we have seen; its existence is to be admitted only after detailed and repeated examination. It does exist, however, and it constitutes one of the saddest infirmities and claims our assistance. We can, alas, do nothing to improve the hearing, but we can and we ought to give the wounded man the opportunities of making up for it, to a certain extent, by lip-reading.

Lip-reading is taught in the schools for deaf-mutes; it has stood its test. The results in the case of those deafened in warfare have answered well to the expectations of those who have taken it up, and the Government has officially instituted this instruction in the majority of centres behind the Army.

It is not for us here to describe the method to be followed, but we will merely formulate a few essential principles.

The results depend greatly on the capability of the teachers; this instruction is not only a work of patience—it needs a knowledge of psychology; it does not consist entirely in teaching the deaf man to recognise a syllable on the lips but also to find out how to put together an entire phrase by means of

the various fragments that he has noted with his eyes. The deaf man, in fact, however well-trained he may be, will only read a small part of single words or fragments of words ; he must be taught, from the first lessons, the work of the brain indispensable for reconstructing by means of thought what has escaped the eye.

When well instructed by specialists in the subject, the deaf men obtain immense assistance from lip-reading.

Should it be reserved entirely for the totally deaf ? Should it be extended to those with great dulness of hearing ?

Opinions on this point are divergent ; the protagonists of auditory re-education vehemently condemn lip-reading on the ground that it allows the ears to be dulled into fatal torpor. We look upon this condemnation as purely theoretical, and we would recommend that the partially deaf should be taught lip-reading as it is likely to render them immense service, and is, after all, the systematisation of what patients have learned unconsciously to do up to the present day.

As for re-education, miracles must not be expected. It is impossible to understand how listening repeatedly to one sound can remedy a lesion. Re-education cannot make a deaf man hear, but it may succeed in teaching him to listen. Its influence is above all a moral one ; it proves to him he is not so deaf as he thinks ; the man injured in the war is a furious "negationist." Perhaps it will teach him better to distinguish certain consonants one from the other, and by that help him to hear the voice.

It is, therefore, only re-education by means of

the voice that we recommend, to the exclusion of apparatuses.

Too much time should not be devoted to re-education, as we cannot expect very profitable results ; our injured men are impatiently awaited in the regiment, in the fields, in the factories ; let us send them back as soon as we can, not, however, without having shown them, by the re-education, that we have done our best to improve their hearing ; but let us be able to tell them that time is a greater teacher than we are.

Preventive treatment.—Sportsmen and artillery officers employed in shooting experiments have long known how to protect their ears against explosions, by means of “antiphones,” little balls of ivory which occlude the meatus.

Could the number of concussions not be diminished by the use of a “war antiphone” ? The problem is a complex one, for the combatant must not be made deaf under the pretext of protecting the ears.

Niel has drawn attention to this question ; Wicart has suggested filling the auditory meatuses with cotton-wool moistened with glycerine and covering the ears and the mastoid regions with ear-caps stuffed with carded cotton ; Bardier has brought out a protector constructed on this principle, and has shown that it does not deafen the soldier to an inconvenient extent. It remains to demonstrate the efficacy of these means and the possibility of putting them into practice. To fill up the ears of a battalion, in a trench, with cotton-wool moistened with carbolised glycerine, at the time of a bombardment, does not appear *à priori* a convenient proceeding.

Laimé's apparatus is simpler, and the man can put

it on or take it off instantaneously. It is composed of two metal drums which cover the ears and are fitted



FIG. 10.—Laimé's protector.

to the integuments by a pad of indiarubber inflated with air. We do not possess any information as to its efficacy.

CHAPTER III

DEAFNESS FROM LESIONS OF THE AUDITORY NERVE TRACTS

The labyrinthine deafnesses considered in the preceding chapter represent the peripheral group of lesions of the percipient apparatus; they are by far the most numerous and are to be explained by deteriorations in the auditory nerve-endings. This sensory paralysis affects the two branches—the cochlear and vestibular—when deafness and abolition of Barany's reflexes are observed at the same time. We have seen this syndrome occurring frequently after fractures of the petrous bone and damage produced by the blow of a projectile on the cranium. Labyrinthine concussion from shell-“wind” generally causes deafness without paralysis of the vestibular nerve. The lesions which we are now about to consider and which touch the course of the auditory nerve tracts, derive their characteristic symptoms from changes in other nerve tracts involved at the same time.

Some of these auditory tracts are not particularly well sheltered from traumatism; wounds in these regions, however, occur so rarely that we do not know of one example published during the war; we shall, therefore, devote only a few lines to this chapter,

contenting ourselves with recalling briefly the symptoms attributable to the different lesions, non-traumatic in themselves, of the auditory tracts. This will save us from discussing their differential diagnosis when we are considering the other varieties of deafness in order to define in particular the difference between purely functional disturbances and those due to organic lesions of the nervous system.

Lesions of the trunk.—The nerve, which belongs to the eighth pair, is exposed, in the internal auditory meatus and the posterior cranial fossa, to compression from fracture, exostoses, gummata, patches of meningitis or abscesses. The facial nerve accompanies it, so that deafness and paralysis of the vestibular and facial nerves may be seen together. A similar association is met with in certain otorrhœas complicated by labyrinthitis, but in this case the aural lesions will be evident and will admit of no doubt.

Compression from a tumour in the ponto-cerebellar angle gives rise to a symptomatology which has been carefully studied by Lannois and Chavanne : namely, trigeminal neuralgia and ocular paralysis occurring in addition to the deafness, facial paralysis and vertigo.

Cerebral tumours produce bilateral hypoacusis by compression of the trunk of the eighth nerve and by cerebro-spinal hypertension.

Tumours of the cerebellum produce bilateral or unilateral deafness generally associated with facial paralysis.

Bulb and isthmus of the encephalon.—The decussation of the auditory nerve fibres is incomplete ; therefore, unilateral deafness is partial when it is

owing to a lesion of the bulb or isthmus of the encephalon. The auditory fibres are separate from the vestibular ones and the deafness is unaccompanied by vertigo. Bulbar foci of softening secondary to arterial lesions can give rise to varying symptoms among which vertiginous disturbances sometimes predominate, but the deafness is incomplete and ordinarily transient.

Tumours of the bulb cause hypoacusis on the side of the lesion in a quarter of the cases. Tumours of the pons cause deafness, which is sometimes crossed; those of the corpora quadrigemina bilateral deafness if they themselves are bilateral, or unilateral and crossed if the contrary is the case.

Cerebral deafness.—We have lately described as cerebral a whole variety of types of deafness which appear very different the one from the other. Some of them are thus designated because they do not appear to depend on an aural lesion, others because they form part of a syndrome in which so-called cerebral phenomena, such as amnesia, hebetude, mental confusion, predominate; others, again, because there is good reason to connect them with cortical lesions.

These cerebral deafnesses are also called psychic, emotional, "concussion" or hysterical, etc.

Such confusion is not worthy of modern otology. We must reserve the title of "cerebral" absolutely for deafness caused by changes in the auditory cortical centre.

We must absolutely define the deafness by an analysis of its exact clinical characteristics rather than by estimating the emotional disturbances which are associated with it; otherwise we shall be rendering no service to the neurologist.

A sufferer from concussion may not present any psychical disturbance but may nevertheless be the subject of hysterical deafness ; another may be affected with real and indisputable lesion of the internal ear and may in addition complain of severe emotional phenomena.

In the light of this, do traumatisms frequently produce cerebral lesions causing deafness ? We do not think so.

A jolt or violent shock induces what is known as cerebral concussion, that is to say a kind of shaking-up of the nerve cells and perhaps minute hæmorrhages, causing motor and sensory disturbances which may vary from mental clouding to unconsciousness and absolute immobility. All the senses are affected including that of hearing. But these sensory disturbances of concussive origin soon pass off unless there is added to them an element of pithiatism.

Beyond this " dizziness " which follows the shock does there exist a permanent deafness produced by lasting lesions of the auditory nerve-centres ?

This centre occupies the middle part of the first temporal convolution.¹ Neither of them, the right nor the left, corresponds entirely to the opposite ear on account of the incompleteness of the decussation of the nerve bundles at the level of the bulb. Symmetrical and bilateral foci of softening produce marked disturbances of hearing and even complete deafness. These are exceptional events.

Otitic abscesses of the temporal lobe fairly often produce aphasia, very exceptionally deafness, and meanwhile the affected ear being deaf, the hearing of

¹ This view is not accepted by all. (See Chatelin and De Martel, *Horizon Collection*.)

the healthy one should be compromised by the temporal lesion of the opposite side and the disturbances of audition should be well marked. This proves what a slight tendency there is for cortical lesions to produce deafness.

Deafness from direct traumatic lesion of the cranium is possible ; as we have just seen, it could only amount to hypoacusis on account of the incomplete decussation ; it is certainly very rare. We do not know a single example.

It seems still more difficult to admit, otherwise than as a very exceptional event, the occurrence of deafness from cerebral lesions resulting from explosion ; first of all because such foci are rare ; paralyses due to a similar cause are exceptional (Claude) ; very few cases of aphasia have been observed and the majority of them are probably of a hysterical or toxic nature (Dumas), for they are often to be observed after simple emotion without any concussion. The mutism so frequently observed is of a hysterical nature. The deafness termed "cerebral" is hysterical or labyrinthine, and if auditory disturbances really due to a lesion of the centres ever show themselves, they will constitute an exceedingly rare exception and cannot take the form of total deafness unless the lesions are bilateral.

CHAPTER IV

FUNCTIONAL DEAFNESS HYSTERO-PITHIATISM—SIMULATION

A functional disturbance is to be distinguished from an organic disturbance in that it does not answer to a recognised anatomical lesion; the proof is that it is susceptible of disappearing completely and suddenly under a purely moral influence.

Do there exist deafnesses answering to this description? The response is unquestionable. Lannois and Chavanne have cured 15 deaf men out of 32 in one sitting.

HYSTERO-PITHIATISM

Definition.—It is impossible to describe aural hysteria without being constantly inspired by Babinski's conclusions which neurologists have almost unanimously accepted, and which Babinski and Froment have clearly set forth in their recent work.¹

Babinski has not done away with hysteria; he has defined its limits; it has become "pithiatism,"²

¹ BABINSKI and FROMENT, *Hystéro-pithiatisme et troubles réflexes* (Military Medical Manuals, University of London Press).

² πείθω, I persuade; -ίητος, curable.

that is to say, the predisposition to exhibit certain morbid phenomena which can be created entirely by suggestion and completely cured by the same mechanism. Hysteria reproduces all that suggestion may create, movement or immobility, imaginary sensation or sensitive and sensory anæsthesia, but beyond that it has no power ; it may cause the most severe and lasting paralysis, but it cannot bring about the most transient reddening or pallor. There is one essential point ; it has no influence on the reflexes.

The hysterical state is distinct from the emotional state, for the latter is accompanied by constitutional phenomena, cardio-vascular, secretory disturbances, etc., which suggestion cannot reproduce or cure. Emotion does not directly create a hysterical phenomenon, but it places the subject in a state of suggestibility which is pre-eminently favourable.

The pithiatic differs, on the other hand, from the simulator in that he has not willed his illness ; it has been imposed on him by an outside influence or an auto-suggestion of which he is unconscious ; hysteria is an unconscious simulation. The simulator, on the contrary, has entirely conjured up his illness. He does not wish to get well. We should be wrong in saying that the hysterical subject wishes to be cured ; he may like his disease either because it enables him to play a part or because he finds advantage in it ; from this point of view hysteria is a semi-simulation. Thus pithiatism exists distinct from simulation, but in a hysterical subject the two elements are sometimes united in a proportion which is difficult to determine.

Etiology.—Never have men had their nervous systems submitted to such severe trials as our infantry

of to-day ; physical fatigue, moral anguish, terrifying sights surpass anything that has hitherto been known ; the deafness alone arising from an intense and prolonged bombardment produces a nervous depression from which there is no escape. What better soil for the development of hysteria ? The faculties of reason and of will disappear and the individual finds himself at the mercy of any suggestion that comes near him.

Babinski attaches little importance to the personal or hereditary antecedents in connection with the genesis of those casualties which we are considering and which arise from "minor hysteria"; "if the major hysteria," he says, "scarcely develops except in subjects predisposed by their birth and their nervous antecedents, if it is the lot of the neuropathic aristocracy, the 'minor hysteria,' on the contrary, is within the reach of everybody." It has seemed to us, however, that the personal equation enters into the calculation ; the worst and most inveterate forms of pithiatic deafness occur mostly in illiterate or very ignorant peasants ; these unfortunate men harden themselves, more than any others, against the attempts of medical suggestion. Appearing to understand nothing, they submit to methods of examination with a bad grace and in fear ; apparently almost indifferent to their lot, they show no desire to become cured ; they have no moral force, nothing in them which could be taken hold of in order to get a grip on them with methodical persuasion.

Pithiatic deafness shows itself especially after the explosion of very large projectiles and particularly of mines ; the emotional state produced by the death of comrades, by being himself buried, leaves the man

defenceless against auto-suggestion ; the emotion by itself would have no power ; there must be suggestion to cause the deafness.

It is not by chance that the wounded man suggests to himself that he is deaf ; there is even no need for such auto-suggestion, for he is really very deaf or at least very much deafened. The aural concussion produced by these noises and the displacements of air of unprecedented violence, do not always leave behind them a permanent labyrinthine lesion, but a kind of auditory stupor accompanied by noises ; "one must make an effort to listen," a confrère who had often passed through these terrible experiences said to me ; those who do not force themselves to listen are deaf. Many of our wounded, who are not subjects of pithiatism, affected with a unilateral traumatic lesion of the middle ear, have assured us that they heard nothing for twenty-four or forty-eight hours. Once this period of stupor is passed, normal subjects begin to hear again, but not so the pithiatics.

Depressed to the utmost limit of lassitude and asthenia, they accept their deafness as a natural consequence of events and do not try in any way to overcome it. On the contrary, they do not think of it except to become more deeply weighed down by the idea that they have lost their hearing.¹

Auto-suggestion has been enough to create the symptom, but hetero-suggestion will exert itself powerfully to augment the effects and to render them more permanent. Directed to a hospital centre, our unfortunate man comes in contact with many other deaf men ; he will see more than one whom the doctors

¹ DUMAS, *Soc. de Neurologie*, 1916.

are unable to cure. Perhaps some nurse (this is becoming rarer to-day) may pronounce some clumsy words of pity with regard to his misfortune ; medical examinations, trials of local treatment, if they are prolonged and fruitless, will convince him still more of the reality of his deafness. All this is classic and hackneyed, and there would be no need to insist on it if it were not necessary for us to remember how careful doctors must be in entering their diagnoses on the various hospital slips and bulletins. Why do we not content ourselves with writing—"apparent deafness," "deafness, detained for observation," "concussion," until we are able to establish an exact diagnosis ? We have too often seen "dislocation of the chain of auditory ossicles," "hæmorrhagic internal otitis," "destruction of auditory organs," "incurable deafness." Let us beware also of discussing the matter before the patient. A young junior officer, apparently sincere and intelligent, said to us one day, "I cannot hear ; I have no light spot."

Clinical description.—We shall describe three forms of aural hysteria—deaf-mutism, total deafness, and extreme dulness of hearing.

Deaf-mutism.—Deaf-mutism represents the most accentuated form of traumatic hysteria of the ear.

We know *à priori*, for certain, that mutism which supervenes under such circumstances, is a purely pithiatic symptom ; but it is not the same with regard to the deafness which is not necessarily pithiatic ; it is possible to imagine the combination of an organic deafness and a hysterical mutism.

It is difficult to recognise the real nature of the deafness on account of the conditions of examination ; all the hearing tests are negative ; the patient hears

no sound ; this, it is true, is very suspicious, for total destruction of the two labyrinths is exceedingly exceptional ; there can be no question of noting the voice while using the noise-machines ; there is, however, one reflex which remains to us, namely, the cochleo-palpebral ; it is of great value. Supposing a slight noise emitted unexpectedly causes the patient to wink, we have the indisputable right to affirm that he has no severe organic lesion of the auditory apparatus. Absence of the reflex, on the contrary, obliges us to be reserved in our opinion.

The mutism is absolute ; the patient utters no sound by the mouth ; he does not speak, he does not whistle ; he makes no attempt to articulate a word or syllable ; he has, however, retained the memory of language ; he reads and writes. The man with aphasia, on the contrary, articulates certain words, but in their wrong connection ; his glottis works, but he has lost his memory for words.

The laryngoscope reveals a perpetually gaping glottis ; the cords make no movement when the patient is asked to utter the sound " eh " and no laryngeal sound is emitted. This pseudo-paralysis is not met with in any known organic lesion ; we possess, however, another powerful argument for calling this hysterical condition a sham one, for Janet, quoted by Dumas,¹ has erroneously written, " We know of no way of causing the cords to come together except asking the patient to call out or utter a sound, but we are concerned with people who can neither call out nor speak and who consequently cannot produce the movements which we ask for " ; the immobility of the vocal cords is of pithiatic origin ; it

¹ *Revue de Paris*, 1^{er} trimestre, 1917.

is limited to movements which the will can command or stop, but the *motor reflex is preserved*; if we make our patient inhale sulphurous acid he will give a sonorous cough; if we provoke the nausea reflex by working the laryngeal mirror about, we shall see the arytenoids come together, so that the constrictors of the glottis perform their function, their paralysis being only apparent.

Besides, organic laryngeal paralysis produces aphonia and not mutism; not only do the vocal cords of the mute remain immobile, but the tongue, the lips and soft palate remain inert during speech, whilst deglutition takes place normally. The purely pithiatic nature of the mutism is, therefore, incontestable.

Roussy has distinguished three varieties of deaf-mutism:—the first consists only of the pithiatic occurrence of deafness and mutism; apart from this the patient is normal, he speaks by gestures and by writing; in the other two, mental confusion is super-added; the patient is either agitated, frightened, haggard with the mental confusion of delirium, or he is stupid and indifferent to everything, with the mental confusion of stupidity.

Course.—The prognosis of deaf-mutism is favourable. Cure always takes place more or less rapidly according to the surroundings and according to the quality of the persuasive treatment. Speech does not at once recover its normal tone; it often remains hesitating and jerky for a time. The return of the hearing depends on the absolute or comparative soundness of the ears.

The presence of delirious or torpid mental confusion makes the situation much more gloomy. Therapeutic

suggestion becomes impossible; besides, the patient no longer belongs to us; the aurist must hasten to resign his place to the psychiatrist as soon as he has completed his otological investigations.

Total or almost total deafness.—Pithiatic deafness is generally bilateral, or, more frequently still, an organic unilateral deafness is complicated by a hysterical deafness of the other side.

The hearing-tests reveal extreme or total deafness for all sounds, as well by bone-conduction as by air-conduction; however—and this is an essential point—the reflexes are preserved. The deaf man who hardly hears you shout, hears himself speak, and regulates his own voice according to his hearing; he shouts when the assourdisseur is used (Lombard); he winks at an unexpected sound in the neighbourhood of his ear (Gault); this preservation of the aural reflexes is as significant as the pupillary contraction in hysterical amaurosis; it altogether eliminates the hypothesis of severe organic deafness.

This does not mean that the hearing is really normal and that the ears are absolutely sound; it merely shows that the hearing is not very much diminished and that the lesions are not severe. It must be remembered that pithiatism may aggravate a real lesion, and it is this association which sometimes renders the problems submitted to the expert so difficult.

Certain hearing-tests are added to the consideration of the reflexes in order to differentiate between organic and functional deafness. These are described in detail in the chapter on Medical Reports, to which we would refer the reader, who will also find the means of distinguishing between hysterical and simulated

deafness in the portion of this chapter which we shall devote to simulation.

Dulness of hearing.—Partial hysterical deafness is distinguished from organic deafness by the preservation of the reflexes and the apparently paradoxical result of certain hearing-tests (Weber's, Stenger's tests, etc.). It is not easy to differentiate it from simulation, and we believe that simulation plays the principal rôle in it; much as we believe in the possibility of total or almost total functional but involuntary deafness, we have equally little belief in simple dulness of hearing. We shall discuss this difficult point of diagnosis later on.

All authors are agreed in describing the difference in the general attitude and outward appearance between the organically and functionally deaf. The really deaf man is extremely melancholy; he cannot be consoled for being isolated from the rest of mankind; he looks upon his life as ruined; he worries about his chance of becoming cured; he follows with his eyes the people who are around him; he never ceases to be interested in what is to be seen around him.

The hysterical man shows, on the contrary, an extraordinary indifference both as to his own lot and to all that is passing around him. He is an automaton to an extreme degree, immobile, set, looking into space; he does not appear to suffer through his infirmity, and soon lives the life of the other injured men in the hospital, that is to say, as long as he has no superadded mental disturbances.

Prognosis.—The course of hysterotraumatic deafness does not follow any fixed rule. It varies to an

infinite degree with the mentality of the patient, his good will, his intellectual and moral value, the intensity of the emotional phenomena, the atmosphere by which he is surrounded, and the manner in which he is treated. An intelligent young man who has good will and self-respect and a desire to be cured, will rapidly improve if he falls into the hands of an aurist who does not find an imaginary lesion, inflict unsuitable local treatment on him or practise suggestion in the wrong direction. The injured man who is somewhat illiterate, glad to have left his regiment and desirous not to return to it but to go home as a pensioner of the State, who knows that deafness is often incurable because he has seen it treated without good results, and who has a right to imagine himself ill as he is cared for with great show by means as odd as they are classical, such a man does not become cured; even when he is placed in good conditions he will still remain uncured, because everything has actually been put in working order for "driving in the nail."

Treatment.—The conclusion to be arrived at from the preceding lines is that there is a series of conditions to be considered if we would prevent severe forms of traumatic hysteria. From the time of the accident the different medical authorities before whom the concussed man comes must avoid mentioning a decided diagnosis of an aural lesion before a systematic examination has been practised.

This examination requires an installation with the necessary instruments, which, however, is quite trifling, as will be seen in the chapter devoted to Medical Reports; and the doctor must in particular

be competent to carry out this type of investigation. Babinski, Vincent and others have repeatedly insisted that a sure and exact diagnosis must precede all attempt at psycho-therapy, for to treat organic lesions by suggestion is to experience failures which lower the prestige of the treatment. The recognised pithiatic man should be separated from the organically deaf, whose example would be far from being salutary, and, further, he should be completely isolated.

The care with which the aurist proceeds with his examination and his air of authority give confidence to the unfortunate man ; the best plan is not to deny the existence of an aural affection at first, but to assert quite naturally that he is free from serious lesion and likely to get well quickly with quiet and rest. During the next few days, according to Gault, "winking" may be advanced as a proof that the hearing has returned, but perhaps it is most advisable, when face to face with the patient, to proceed for the most part with assurances rather than arguments. The sojourn in the otological clinic should not in any way be prolonged ; if the patient recovers his hearing he should be sent away for a short period of convalescence with the indispensable precaution that a very exact and precise statement of the condition of his hearing at the time of his discharge from hospital should be written on his hospital report, failing which a relapse would be very likely to occur when he is in his own home. Should the aurist come to a deadlock he would only lose his time and his prestige by delay, and would do better to send the patient to a modern neurological clinic where appropriate psycho-therapy would be employed by practised experts.

Success is generally obtainable when the accident has taken place only a few days or weeks previously. It becomes very problematical when the case is that of a man injured long before, and who has been the object of diverse diagnoses and attentions, who has known many cases of uncured deafness, and above all who has perceived in his deafness a definite means for not returning to the fighting. He becomes a pithiatic and a simulator, the simulation being superadded in an indefinable proportion ; but inasmuch as they are pithiatics, they are patients who must only be returned to the Army when they are cured ; their commanders can make no use of them, and their remaining inactive in the dépôts is a nuisance from every point of view.

Babinski recommends trying abrupt treatment straight away ; this method affords him many successes in curing motor disturbances ; we have seen that Lannois and Chavanne have had recourse to it ; it consists in taking advantage of the emotion produced by arrival at a new hospital, of the moral ascendancy of a fresh expert who gains the patient's confidence at the onset, and assures him authoritatively that his ear is not destroyed, that he can hear, that he must hear, that he does hear. " If such declarations appear to humiliate him he should be made to feel that such a state of mind, after the concussion to which he has been submitted, is compatible with very sound intelligence, excellent morale and great courage." ¹ This persuasive assault seldom succeeds except with subjects of a certain amount of culture and moral tone.

How are we to act if the first attempt fails ?

¹ BABINSKI and FROMENT, *loc. cit.*

Some have advised instituting an appearance of treatment for these imaginary deafnesses with the idea of suggesting progressive amelioration in the first place and finally cure; they are submitted to our old therapeutic proceedings—massage of the tympanic membrane, insufflations, catheterisations. But to irritate an ear which is not to be benefited by such treatment, is to deafen it momentarily, a condition little favourable to the desired suggestion, and to persist in such manipulation is to risk driving in the malady rather than to eradicate it.

We must, however, do something; discreet re-education is then permissible. But the significance of such re-education must be understood; it is only an appearance; it has not for its object the teaching of hearing over again to one who has not lost the power; its only object is suggestion. It should be of the very simplest; the teacher should show his pupil, if he wishes to obtain his confidence and attention, that he will hear simple noises and sounds first and more complicated ones later. This re-education, in some ways purely moral, should also be as little systematic as possible; it will serve to elicit the good will and intelligence of the patient; it should not be continued in case of failure. *The teacher must be warned that he is between two great risks—that of believing that it is he who cures the deafness and that of exercising a contrary suggestion.*

On no account should these patients be kept long in otological clinics; they should be sent to a neurological clinic when they do not improve rapidly. They should take with them a case-paper containing details on which the aurist has noted his diagnosis of functional or hystero-organic deafness, and on

which he has clearly and fully set forth his opinion. Our modern neurologists are often marvellously experienced and equipped for the cure of these pithiatic disturbances which belong more to them than to us, while they alone are at the same time qualified to appreciate the nervous or mental disturbances associated with the deafness.

However, they sometimes fail. In the same way that a trouble will not be cured until the removal of its cause, so many pithiatic disturbances will not disappear until after the War.

Of course if we find ourselves confronted by a hysterio-organic combination and if the organic lesion allows of a course of treatment favourable to the patient, advantage must be taken of it, this being the most efficacious treatment. For example, if there should be a unilateral organic deafness with pithiatic deafness of the other ear—a frequent combination—we must not hesitate to propose our man for the auxiliary service; we shall then not have much difficulty in persuading him that he hears with the good ear.

SIMULATION

Simulation of total deafness is rare; exaggeration of real dulness of hearing is more frequent; the attempt at fraud pertains only to the severity of the infirmity or to its severity and its origin, according as the patient is content to exaggerate a war-deafness or wishes to attribute a recent traumatic origin to a lesion which is certainly of old standing.

Etiology.—We did not see one simulator during our sojourn in a divisional ambulance; simulation

is not a malady of the Front ; it is contracted behind the lines and above all at home ; it is contagious and is caught either in the hospital or during convalescence ; little epidemics are to be observed when the nosocomial surroundings favour its development.

We hardly know of any individual predisposition for exaggeration ; it is so conformable to our poor human nature ! On the other hand, simulation of total deafness is especially observed among soldiers without intellectual culture ; it constitutes a veritable torture for a man with even a small amount of intelligence, unless he sets up for being a lip-reader.

Symptoms and diagnosis.—A. Total deafness.—Simulated deafness is the most absolute ; no sound at all is perceived and all the hearing tests are negative.

The “assourdisseur” and cochleo-palpebral reflexes are present in their normal form, and there would be nothing to differentiate the simulator from the hysterical subject unless he professed often to be able to lip-read when he really does not read, but hears like any one else. We shall explain at length in the chapter on Medical Reports our way of finding out sham lip-reading. We would only say here that we consider it a proof of conscious falsehood, while Babinski and Froment look upon it as a manifestation of hysteria ; it does not seem possible to us that the simulator of deafness should unconsciously play this farce of learning lip-reading by degrees and that he should ignore hearing us when he has his ears as the only means of understanding us. The attitude of the simulator who does not lip-read has attracted the attention of all observers, as it is so singular ; the

man, feeling himself observed, tries his utmost not to become agitated; he knows himself to be at the mercy of a surprise or a start; he is also nervous and generally keeps his eyes fixed on the ground, always keeping apart from people or things going on around him; it is not the automatism, the natural indifference of the pithiatic; it is voluntary abstention from all movement and all imitation.

Unfortunately an attitude does not constitute a sufficient basis for the formation of a medical report. If the preservation of the reflexes differentiates in a certain and objective way between organic and functional deafness, the distinction between hysteria and simulation is often impossible; we shall see presently that this is not of practical importance.

B. Partial deafness.—The man acknowledges that he hears something; the different hearing tests allow of our judging between what is true and what is false in the way we shall show in the following chapter. Although relatively easy to distinguish it from true organic deafness, it is still difficult to make the diagnosis between it and hysteria.

Conscious and unconscious simulators have in common the preservation of the reflexes and an erroneous appearance of deafness when the affected ear is apparently being tested, but at the same time the hearing of the good ear is being observed (perception of sharp sounds with the deaf ear, the absence of the "false" negative Rinne, paradoxical Weber while the good ear is stopped up, Stenger's, Escat's and Bourgeois' experiments). But the characteristic of the simulator is the great variability of his answers; he is generally caught by the test of the loud voice, with the eyes shut.

We have described the classical attitude of a man falsely affecting total deafness ; that of the partially deaf deserves also a few lines. Far from being motionless, he makes signs in an exaggerated manner ; he will not hear except at close quarters and then very badly ; if you question him he gets up after you have spoken, leans towards you almost touching your face ; he repeats your question in order to impress the fact on you that he has not heard it ; it is not enough to say he repeats it ; he shouts it out. This bit of business is not constant, but fairly frequent and characteristic.

Course to be followed.—It is a serious matter to certify on a medical observation sheet that a man is a simulator, and this should not be done without absolute certainty. The aurist should remember the possibility of hystero-organic association and the difficulty of diagnosing between hysteria and simulation ; he will remember also that the simulator is often suffering mentally and really ill. Our rôle is not to accuse but to cure ; hysterical subjects and simulators can be cured by moral influence, and we should in the first place have recourse to it ; we may be pardoned for failing where suggestion is concerned because it is not our profession, but belongs to others who have been trained in practising it.

Let us confine ourselves to a detailed examination of these patients ; let us establish a precise diagnosis of functional deafness, and let us refer them to our neighbour, the neurologist, with a very complete report.

As for exaggerators, let us treat them according to their genuine infirmity. It is not enough to say that a man exaggerates ; we must in any case

know what he is worth from the auditory point of view and classify him according to this valuation; we are not appointed to fill the depôts with semi-deaf men or even exaggerators, but to put each in his place.

FOURTH PART

MEDICAL REPORTS

The drawing-up of medical reports may not in this war constitute the aurist's most important work, for, to-day as always, medicine is before everything else the art of healing ; but it has revealed to us some of the most difficult and newest problems.

The number of affected ears exceeds all anticipation ; total or partial deafnesses, permanent or curable, real or simulated, require frequent examination in regard to the question of discharge or indemnification.

Otorrhœics and partially deaf men have been incorporated in large numbers and the greater part of these are perfectly fit for combatant service ; they will prove to be useful soldiers provided those in command are assured that they can and ought to serve. If wrongly selected they become a dead weight in the Army, an encumbrance to the hospitals and a social evil.

Medical reports have, then, as their aim, the indemnification of those with severe traumatic deafness, and the discrimination between those who are fit, those suitable for auxiliary service and those for exemption. They resemble in many points the medical reports of peace time, on accidents during

work or in the street, but the war has considerably enlarged the field of our observations and calls for the application of important new methods.

The expert must not look upon himself as the advocate either of the State or of the injured man. He takes neither side; he surrounds himself with all the data which go to confirm the statements of the man while he takes all necessary precautions for testing his sincerity and guarding against any possible exaggeration. He does not, *à priori*, look upon all the patients as simulators; he commences his examination without any pre-conceived idea.

The medical report will include the previous history, objective examination and functional tests of hearing and equilibrium.

CHAPTER I

PREVIOUS HISTORIES

A consideration of the previous histories is of great importance.

We find out whether the patient had discharge and suppuration from the ear before the war, ascertain precisely the duration of such and the mode of treatment adopted. We enquire also as to the hearing. The fact of his having followed a particular profession proves that the injured man could not have been very deaf; we must know whether he has been declared "fit" for military service, or if he has been exempted, and why? Extreme deafness being incompatible with active service, we would admit that it could not have existed at the beginning of the war.

A man with dulness of hearing and presenting ordinary lesions of the tympanum such as retraction of the membrane, is to be suspected at once if he attributes his infirmity to a recent injury; it is, therefore, a good plan to order an enquiry to be made by the constabulary of the neighbourhood he previously frequented; we can also write to the officer in command of his company to find out if he was known to be deaf before his injury.

We acknowledge that these official researches rarely have satisfactory results: the regimental

enquiry because it is difficult to remember these points, often on account of the witnesses having disappeared; that of the constable because the veracity of neighbours and comrades is open to question. Nevertheless, this element of information should not be neglected.

The official request for an enquiry might be worded as follows :—

*“ The principal Medical Officer of the Centre O.R.L.
To the Officer commanding the Constabulary of N . . .*

“ I beg to request you to be good enough to proceed with a discreet enquiry with regard to the deafness of the man named X . . . formerly in the Army.

“ We wish to know what profession he followed and whether he was looked upon as deaf or dull of hearing.

“ It will be necessary to enquire of his neighbours, his workshop companions, etc., in the first place, and as a last resort, his relations and parents.”

The circumstances connected with the injury are carefully set down; the position of the man in relation to the exploded projectile has, we believe, a certain value, the deafness being generally much more pronounced in the ear turned towards the projectile; being buried produces an intensely emotional state favourable to the development of functional deafness; the unhappy men who have seen the same shell kill their comrades around them are equally predisposed to this condition.

We enquire, in regard to the immediate consequences, as to loss of consciousness, loss of

memory, total deafness, bleeding from the ear. The word "vertigo" should never be mentioned, but we ask the injured man how he got up, how he arrived at the aid-post, if he was able to walk alone directly afterwards and during the following few days, if he had nausea and vomiting; we enquire as to when the discharge from the ear commenced, as to its nature, its quantity and the treatment employed.

The discharge papers and the various hospital reports will be collated in order to find out any mention of deafness, tympanic rupture or otitis, and accurate information with regard to the onset and course will be insisted on.

Not one of these details is superfluous; this enquiry, if well conducted, furnishes important points in establishing the sincerity of the man interested, as it may also prove his bad faith in a very evident manner.

Let us take a few examples from among the most frequent: a man is injured in the limbs; he is discharged on an ambulance with a paper mentioning this injury exclusively; he passes through several hospitals without one report mentioning a lesion of the ear; he decides eventually to complain of deafness which he attributes to an explosion; you examine him; you ascertain old lesions and you can affirm almost positively that his history is false from beginning to end. A second example: an injured man is discharged and treated for a left-sided traumatic deafness; he obtains leave for convalescence; he returns to his regiment completely deaf in both ears and unfit for service. Is not this history very suspicious from the beginning?

The expert should, therefore, proceed with this

enquiry with the vigorous method of an examining magistrate, without omitting anything and always exacting precise answers checked by the papers he holds in his hands, allowance being made, moreover, for possible imperfections in these papers.

CHAPTER II

OBJECTIVE EXAMINATION

Traumatic deafnesses follow either blows on some part of the cranium which transmits them to the internal ear, or injuries of the organ of hearing itself.

In the first case the expert describes the character of the cicatrices, carefully noting their situation and the condition of the subjacent bone ; the description need not be a long one.

The anatomical condition of the ear necessitates on the contrary a detailed statement mentioning exactly the normal or abnormal condition of each part.

We pass quickly over cicatricial lesions of the auricle and auditory meatus, because their traumatic origin is as a rule free from doubt.

The presence of blood or of a clot at the bottom of the meatus is a point of considerable importance when the injured man is seen soon after the accident, for it furnishes a practically indisputable proof of recent traumatism.

One of the principal difficulties in making a medical report rests, on the contrary, in distinguishing old lesions from recent injuries of the tympanic membrane and cavity.

The membrane is generally normal in cases of

extreme deafness following concussion. It has fairly often seemed to us to be depressed under similar circumstances, and we ask ourselves if there exists here a simple coincidence between an old-standing condition and a recent explosion, or whether a sudden and violent displacement of air cannot produce a definite change in the position of the membrane and ossicles; this would be a possible mechanism for the genesis of certain deafnesses. Experiments on animals would probably give us information on this point.

We must distinguish between this simple driving in, which is perhaps traumatic, and depressions and pathological retractions following an *old tubo-tympanic catarrh*. The handle of the malleus is then retracted and more or less horizontal, the promontory and the anterior and posterior folds project; the appearance of the membrane is altered; concomitant naso-pharyngeal lesions are found. The membrane without being retracted may look dull, lustreless and dark, it may present calcareous infiltrations or zones of thickening or atrophy; these lesions, indicative of old-standing sclerosis of the tympanum, are easy to differentiate, but we cannot always distinguish between a cicatrix of a few months' duration, due to the war, and an older pathological condition. Recent injuries of the tympanic membrane are recognisable, as we have seen, by the presence of blood and later of a clot in the depth of the meatus.

Sometimes an ecchymosis is all that may be seen on the membrane; this is a very important point. Again, a recent non-infected perforation may be recognised by the surrounding parts being normal. If infected and complicated by a profuse suppuration

which pulsates, it is difficult to distinguish it from an ordinary acute otitis. When seen after several months it cannot in any way be differentiated from a chronic suppurative or cicatricial otitis. There are, however, numerous cases in which the old-standing pathological nature of the otitis is indisputable. We do not acknowledge, for example, the possibility of traumatic perforations of Shrapnell's membrane. Certain well-marked lesions of the tympanum with very pronounced retraction or partial destruction of the malleus, an old-standing cicatricial appearance of the zone of the promontory, etc., do not present any doubt to an experienced eye.

Our objective examination here reaches its limit. Less fortunate than the oculist who can see the retina, we cannot directly ascertain lesions of the internal ear, and we have to resign ourselves to our inability to identify them except by the functional disturbances.

CHAPTER III

FUNCTIONAL EXAMINATION OF AUDITION

It is not enough in these days to draw conclusions from impressions, to argue from the patient's attitude assumed to be more or less sincere, to prepare traps for him, to be a rival with him in ruse and patience. We must investigate his hearing-power methodically, making it, as far as we can, impossible for him to deceive us, and above all we must control his statements by a study of the reflexes which are independent of the will.

The discovery of the cochlear reflexes raises the medical reporting in regard to the ears to a degree of precision hitherto impracticable, and greatly increases the value of the conclusions.

There is an enormous difference between a medical "report" and a clinical observation ; whoever prepares the first in the same way as he would make the latter lays himself open to gross errors.

Clinical observation requires the absolute good faith of the observer and the subject. If there is a chance of the reader suspecting either one or the other, the observation counts for nothing ; the sincerity of both parties must be admitted *à priori*.

In the making of a medical report the moral and

scientific status of the doctor is above suspicion. The State is possessed of every possible guarantee before selecting him, for the specialist expert is the most powerful of all, being generally alone and open to neither control nor dispute.

The sincerity of the soldier to be examined cannot be admitted *à priori*. We must certainly not suspect every man of being a simulator; simulators will not be very numerous; they will be much fewer than might be expected from our knowledge of the ways of those who have met with accidents during their work or in the street.

However, exaggeration of deafness is so tempting to some and so easy to accomplish, that we are quite permitted and even recommended to be always on the defensive against it.

The recognition of a peculiar psychological substratum hinders us from considering the results of our different examinations as precise scientific data; our sole other aim has to be to attain to *approximations* sufficient to classify our men according to their acuteness of hearing from the military point of view.

We are of the opinion, for the same reason, that our injured men furnish us with poor soil for the scientific study of the treatment of deafness; the results can only be uncertain, the conclusions—to say the least—hasty and subject to reserve.

PRELIMINARY INVESTIGATION OF THE HEARING FOR THE SPOKEN VOICE

The systematic examination of the hearing should not be made at the commencement but at the end of

the making up of the medical report. The patient puts himself on the defensive the moment this examination is started, and if he then refuses to listen to us or to understand us, it is all up and we shall never get any answer from him; he will hold on to the acquired result, either by auto-suggestion or by voluntary effort; he will fix his deafness in some way at the degree marked that day, and this will be the same during the whole time of his stay in the hospital.

A preliminary insight into his hearing-power will be arrived at while questioning him and interesting him in the circumstances of the injury, in what followed immediately afterwards, in giving him some easy orders to carry out, which are apparently necessary for the formalities of the investigation or the objective examination.

As head of the aural department, we employed the following technique: the injured man did not come directly to us, but to our secretary, who questioned him and who was placed in such a position as to enable us to see and hear without appearing to do so. We then questioned him; we examined his papers with him; and then we carried out the preliminary objective examination. We at once noted down the maximum distance at which the spoken or shouted voice was heard with one ear or the two during this first interview, so that we possessed from that time an irresistible argument if later on he refused to answer.

We should like to place in this first stage of the examination a test as easy as it is demonstrative and for which we are indebted to one of our colleagues; it consists in testing the hearing while appearing to measure the acuteness of the sight; the man is placed

at one end of the room, the ordinary test-types used by oculists being fixed on the opposite wall; the observer placed between the two at a varying distance from the would-be deaf man, gives him some simple directions such as "shut the right eye, the left, read the third line, step forward, step back, etc.," and notes at what distance he hears.

MEASUREMENT OF HEARING-POWER

It is permissible after these preliminaries to commence the medical report properly so called; we already know whether the injured man presents himself as totally or partially deaf.

The examination should take place in a sufficiently large and quiet locality in the presence of witnesses belonging to the personnel attached to the hospital, but no sick or wounded patient should be present.

This examination does not call for the employment of all the methods for measuring the hearing; it has an aim which is more practical than scientific, namely to be as simple as possible while being sufficient so as not to call for complicated instrumentation or considerable loss of time.

We satisfy ourselves completely for our own part as to the points in the case-paper issued by the Ministry of War, while allowing ourselves some modifications as expressly authorised on this form, according to the views of each experimenter; and we shall now conform to the order in which the different tests succeed each other.

The watch.—We begin with the simplest hearing-test, namely the watch. It is freshly wound

up and applied on the mastoid process and on the temple, and we note whether or not it is heard by bone conduction.

Air conduction is investigated in the following way : the subject is seated, with the eyes closed and the opposite ear stopped up ; the watch is at first held at a distance and then approached by degrees to the ear being examined, following a perpendicular axis or sagittal plane ; we note the distance at which it is first heard ; the test is repeated several times for each ear.

This test is within the reach of everyone, but *in our opinion is of no value*. We attach no importance to the absence of bone-conduction seeing that it cannot be controlled.

The absence of air-conduction cannot be controlled either. Defective air-conduction would be, we may be told, difficult to simulate, as the subject has his eyes closed and does not know the distance of the watch; he exposes himself, if he is desirous of deceiving us, to discrepancies which prove his bad faith. This argument is not valid, for the patient has only to wait each time until the "tic tac" seems very loud to him in order to be able to deceive us sufficiently and regularly.

In practice we have noted that deaf people hear the watch particularly badly ; we are not the only ones to note this. Moure has written : "A very interesting fact to be noted in soldiers is the difference which exists between air-conduction for the watch and for the spoken voice. The patient who hardly perceives the 'tic tac' at from 1-20 cm., hears, on the contrary, the ordinary voice several metres away, often from 4 to 5 and even further than that."

We believe that this peculiarity of war-deafness is attributable to a certain psychological condition of the injured man rather than to anything else, and we repeat that non-perception or poor perception of the watch signifies nothing.

Tuning-fork.—Tuning-forks help us to establish data of considerable importance. They will contribute to measuring the acuteness of the hearing by air-conduction; they will give information as to the extent of bone-conduction for sounds; they will permit finally of comparison between the two modes of perception for each ear.

The study of the *perception by air-conduction of definite sounds* indicates the degree of the lesion, and to a certain extent its situation in the middle or internal ear, and even in both if they are affected simultaneously.¹

Deep-toned tuning-forks.—For examining the *perception of deep tones* we use Gradenigo's tuning-forks of 32, 64, and 128 double vibrations per second, the weight on which, while being opposed to the formation of harmonics, allows, thanks to the index inscribed on its external surface, of measuring the

¹ We know that any involvement of the middle ear affects the perception of low-pitched sounds by air-conduction, and that a labyrinthine lesion, on the other hand, affects especially the perception of high-pitched sounds. In the former case it is the lowest-pitched sounds which cease to be heard in the first place; the lower limit of perception is raised, so to speak, proportionally to the degree of the lesion; in the second case it is the perception of the highest pitched sounds which disappears first, and the upper limit is lowered as the lesion increases. The ascertainment of a disturbance of hearing for sounds situated at one of these extremities of the normal scale localises to a certain extent the lesion in one or other part of the ear.

This comparative study of the different tuning-forks constitutes a useful, but not indispensable, test. We may quite well content ourselves with the two tuning-forks indicated on the ministerial form.

amplitude of the vibrations and consequently of examining each ear with a sound of the same intensity. This index consists of a black triangle on a white background; it is divided into four equal parts by three black transverse lines. If the prongs of the tuning-fork are made to vibrate vigorously two black triangles separated by a clear space are seen at first. As the amplitude of the vibrations diminishes these two triangles approach one another and soon overlap by their inner margins; then there is to be seen

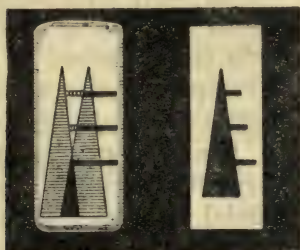


FIG. 11.

FIG. 12.

Gradenigo's tuning-fork. Fig. 1, the index in motion.

Fig. 2, the index in repose.

between the two original triangles a third *black* one, the apex of which reaches the lowest line, then the two upper lines, and ends by becoming blended with the index-triangle when the tuning-fork ceases to vibrate.

For this test, the tuning-fork being set in vibration, we wait till the apex of the little median triangle reaches the lowest line, and then place it opposite the entrance to the external auditory meatus and count from this moment the duration of perception. We investigate by this means each ear separately

with each of the three tuning-forks and write down the results.

It is not necessary, during this examination, to stop up the opposite ear; the deep-toned sonorous waves only extend a short distance and cannot reach the other auditory meatus.

High-pitched tuning-forks. Galton's whistle. Mono-

chord.—Examination of the *perception of high-pitched tones* is made either with tuning-forks, Galton's whistle, or better still, with Struycken's monochord. *The use of high-pitched tuning-forks* is not devoid of inconvenience; a complete series such as Edelmann-Bezold's is costly and does not attain to the uppermost limit of sounds normally perceived by the ear. The official form includes only the tuning-fork c^2 (ut^4). To this is added Galton's whistle, or better still, Edelmann-Galton's, an apparatus which affords a continuous series of sounds from 6,000 to 30,000 vibrations.



FIG. 13.—
Galton's Whistle.

We prefer for an acoumetric examination of the labyrinth Struycken's monochord, a simpler and more exact apparatus and which replaces all preceding ones.

Struycken's monochord consists of a steel wire extended between the two curved extremities of a graduated rod; one of these extremities, which is widened, constitutes the fixed point of attachment of the wire; the other supports a regulating screw by which the wire can be stretched more or less tightly.

Lastly, on the ruler is a sliding weight which limits the vibrating portion of the wire.

The instrument must be arranged in such a manner that when the slider is placed exactly on the figure 44 of the graduation in centimetres, the wire set in vibration by a blow from a little wooden hammer,

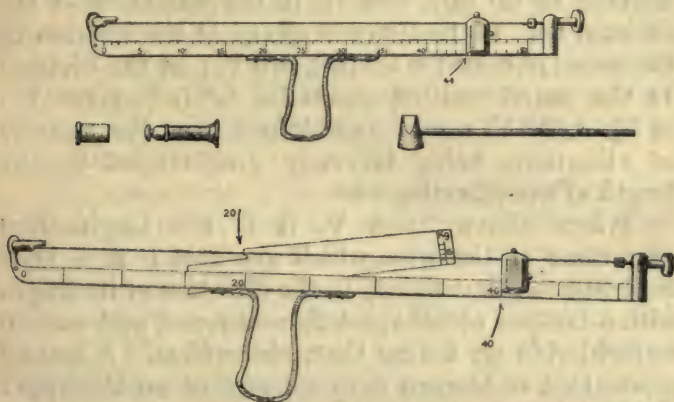


FIG. 14.—Struycken's Monochord; degree of tension of the wire.

gives the la^3 (a^1) (435 double vibrations); a tuning-fork of the same tone, contained in the case, serves as a standard; the wire is tightened or loosened until unison is obtained.¹

According as to whether we use the transverse

¹ Struycken has invented an ingenious method of control; instead of determining the sound emitted he measures the tension of the wire. The slider being at the division 40 he places the controlling apparatus on the monochord in such a way that the upper support rests on the wire directly above the division 20 of the centimetric scale, the lower support projecting on to the lower border of the monochord. The wire must be tightened or loosened so that it covers the division 25 written in red at the other extremity of the measuring apparatus.

or longitudinal vibrations of the wire, a continuous series of pure sounds from 435 to 24,000 vibrations is obtained.

For testing, the rounded end of the apparatus is placed 1 cm. from the auditory meatus and the wire is struck with a little wooden hammer; the sound emitted is la^3 (a^1), 435 V., if the weight is at the division 44. If the latter is placed at the division 22 the sound obtained is la^4 (a^2), 970 V.; at the division 11 the sound emitted would be la^5 (a^3), 1,940 V.; at $5\frac{1}{2}$, 3,880 V. would be obtained, etc., the number of vibrations being inversely proportional to the length of the vibrating wire.

When above 5,000 V. it is the longitudinal vibrations of the wire which are used; it is then sufficient to rub it lightly in the direction of its length with a tampon of felt specially moistened with carbon tetrachloride or, failing that, chloroform. A second graduation in Roman figures inscribed on the upper border of the rod indicates at what point the slider should be placed to obtain 6,000 V., 7,000 V., etc., up to 25,000 V.

The test is made once or twice and the maximum number of vibrations perceived with each ear is noted.

In reality, testing the high-pitched tones only gives accurate results in bilateral labyrinthine deafness. In unilateral deafness the stopping up of the auditory meatus of the opposite side does not shut out the sound from that ear; it is necessary to use a "deafener" (*assourdisseur* or "noise-machine") in order to totally eliminate it, but the noise of the *assourdisseur* extending by bone-conduction to the ear being examined, detracts from the precision of the examination.

On the other hand, we possess in this a means of very strongly suspecting simulation of unilateral deafness if the man being examined pretends not to hear the tuning-fork c^2 (ut^4) vibrating in front of the ear which he says is deaf, whilst the good ear is left open.

Schwabach and Rinne's tests.—*The measuring of bone-conduction* goes by the name of Schwabach's test; it serves for estimating the hearing-power of the internal ear. It is of the utmost importance for us who see so many cases of labyrinthine concussion.

The comparison of the bone- and air-conduction of each ear is called Rinne's test; we combine it, so to speak, with the preceding one so as to read at a glance: how the ear perceives the tuning-fork by the air, how the isolated internal ear hears the tuning-fork vibrating on the bone; the relation between these two numbers informs us as to whether the lesions concern the conducting apparatus or the percipient apparatus most—the middle ear or the labyrinth.

As for Weber's test, we shall see later how useful it is.

The tuning-fork used is c (ut^2). The observer holds it by its foot and strikes the flat end of one of its prongs on a resistant immobile non-metallic object, wood by preference; he strikes without violence but with resilience; the best way is to let the tuning-fork fall by its own weight in order to obtain a duration of vibrations which is practically always identical.

The observer sets his watch going at the same moment as he strikes, and he then places the foot of the vibrating tuning-fork, quite flat, on the base of the



FIG. 15.—The observer strikes the tuning-fork and looks at his watch.

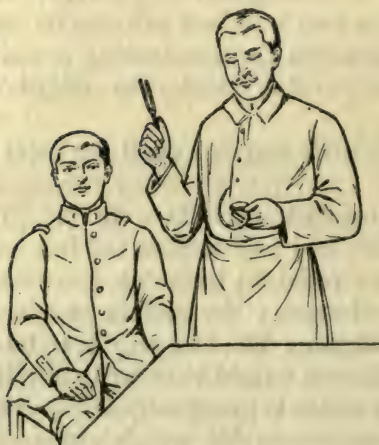


FIG. 16.—He waits a few seconds before putting the tuning-fork on the mastoid.



FIG. 17.—The patient announces the cessation of hearing.
The observer looks at his watch.

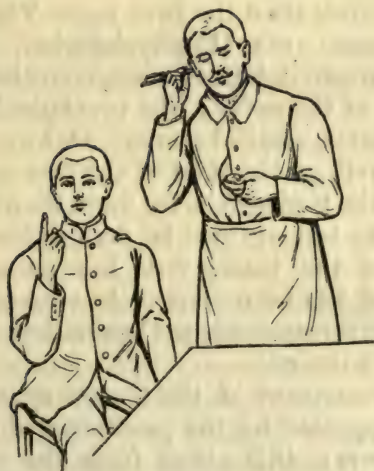


FIG. 18.—The observer calculates how much more his own
perception is than that of the patient.

mastoid process ; the patient announces the cessation of the auditory perception the moment this takes place ; the duration of the perception is noted in seconds. Should this figure be very low, we register it such as it is, after checking it by a second identical test. Should the number of seconds be greater, the experiment is repeated in the following manner : we strike the tuning-fork and set the watch going as before, but we let the tuning-fork vibrate in the air and wait, before placing it on the mastoid, until three-quarters of the time formerly marked down has passed ; only then do we place the foot of the tuning-fork on the mastoid process and stop the watch at the exact moment when the patient says he ceases to hear it.

The number of seconds indicated by the watch gives the real degree of acuteness of hearing for the tuning-fork by bone-conduction ; it is most often markedly higher than the first test. The reasons of this difference are : (1) physiological, (2) psychological. The physiological reason is known to all ; it is fatigue of the nerve ; the psychological (Gosset) is peculiar to the medical survey. Our man may have thought it well, at the time of the first examination, not to hear the tuning-fork for more than 15 seconds ; you start the test again ; he does not suspect that the force of the tuning fork has been expending itself while it has been allowed to vibrate in the air, and he thinks it reasonable not to simulate a perception lower than 15 seconds.

The measurement of the bone-conduction of one ear is accompanied by the possibility of making the greatest errors ; this arises from the difficulty of eliminating in certain cases the hearing of the ear not under examination.

The principles of the problem are as follows : given two internal ears almost equivalent, the vibrating tuning-fork on the right mastoid process transmits its vibrations across the cranium to the two internal ears, but the sound is perceived much more loudly by the right ear, as excitation of the left acoustic nerve does not reach the field of consciousness and is practically negligible.

Given two internal ears very unequal, the right very bad, the left normal or nearly so. I set the tuning-fork vibrating and place it on the right mastoid process ; the patient listens, but *à priori* I cannot know if he hears with the right or the left. I shall check this by stopping up the right ear as soon as the patient ceases to hear it ; if the sound reappears in the right ear it shows that it was perceived by the right cochlea ; if not, I repeat the experiment, stopping the left ear, and the sound reappears in the left ear, the tuning-fork still vibrating on the right mastoid process ; the conclusion is in favour of the left cochlea.

I must then eliminate the hearing of the normal left ear entirely if I wish to measure the hearing capacity of the badly affected right internal ear, and for that I shall use a "deafening" apparatus for the left side.

We shall later on describe Lombard's *assourdisseur*, which is most practical. It has something of a drawback, for, by transmission through the skull, it deafens not only the ear that we wish to eliminate, but also to a certain extent the one being investigated.

Let us suppose again that the right ear is for functional purposes destroyed and the left ear normal ; I place the tuning-fork on the right mastoid process ;

the patient says, "I hear it." As the other tests and the antecedents will have made me distrustful of this false perception, I verify it by the use of the noise-machine to the left ear, and I ascertain that in reality the right internal ear hears nothing. The right ear would not, of course, have heard the tuning-fork by air-conduction. Lermoyez and Hautant have given the name of *false negative Rinne* to the result (apparently paradoxical) of suppression of air-conduction with preservation of bone-conduction in cases of unilateral labyrinthine deafness when the hearing ear is not closed by the noise-machine. We shall see at the end of this article that this *false negative Rinne* constitutes a real test of sincerity.

Summed up this is very simple and might perhaps be stated in a few lines; the reader will excuse the length of this digression; we wished to be as clear as possible as the question has appeared to us to have been sometimes made obscure and complicated, as if on purpose. Let us remember when we are examining one ear always to eliminate the hearing of the other.

Let us return to Schwabach's test; we have noted down in seconds the bone-conduction of each ear for the tuning-fork *c* (*ut*²). Is this sufficient? By no means. What is it we wish to know and note? The patient's degree of deafness. You would read later on in his case-paper, "Schwabach=10," which would tell you nothing, for as you do not know the tuning-fork, or with what force I struck it, you do not know—in a word—how the patient would have heard it if he had not been deaf. Here is indeed a problem. I must then, when the patient ceases to hear it, apply the tuning-fork on the mastoid

process of my own presumably sound ear and note how many seconds I hear it longer than he does ; I note it down ; then alone can we know if the man was slightly or markedly deaf.

This comparison between the patient's and the observer's ear is not strictly scientific, but it is sufficient for practical purposes.

The long commentaries which we have devoted to the study of bone-conduction for the tuning-fork c (ut^2) will permit of dealing more shortly with "air-conduction."

The tuning-fork, struck as before, is held with the end of its prongs opposite the entrance to the auditory meatus ; we note down the duration of the perception and compare it with that of the normal person ; we allow the tuning-fork to vibrate a little way off before bringing it close to the meatus, and we even withdraw it and approach it alternately whilst the ear is listening to it, so as to avoid fatigue of the nerve.

This done, we possess four data, the duration of perception of the vibrating tuning-fork on the mastoid process of the ear being examined and on that of the normal person, and the two corresponding amounts for audition by air-conduction.

We formulate this quadruple result as follows :—

$$\text{Tun. F. } c \text{ (} ut^2 \text{) R. Ear} \left\{ \begin{array}{cc} \text{air } x'' \text{ instead of } n'' & \text{---} \\ \text{bone } x''_1 & n''_1 \end{array} \right. \text{L. Ear} \left\{ \begin{array}{cc} y'' \text{ instead of } n'' & \text{---} \\ y''_1 & n''_1 \end{array} \right.$$

Is not the information thus furnished more complete and more precise than the classical formulæ :—

Schwabach + or —

Rinne + or — ?

Weber's test.—Everyone knows of what it consists; the vibrating tuning-fork *c* is applied to the forehead; it is localised to the side of the deaf ear if the deafness is due to a lesion of the conducting apparatus (middle or external ear); it is localised to the side of the good ear when it is the cochlea of the deaf ear that is affected.

We shall not dwell on the psychological difficulties which are experienced with this simple test. We all know that a person of good faith and even intelligence nearly always begins by localising the sound in the good ear, even if he really hears it in the deaf ear as a result of involvement of the middle ear; he is so persuaded that his ear is deaf that the auto-suggestion is inevitable. The conclusion arrived at from this is that while guarding against dictating the answers to the patient, the experiment should be repeated a certain number of times asking him to be careful of his answers, until a conclusive result can be registered.

Weber's Test, when decisive, gives some valuable information for the medical report.

We quote the following cases as examples of this :
(1) Cicatricial otitis or old-standing otorrhœa, without any sign of recent injury; the man proclaims himself deaf since an alleged concussion. Lateralisation of Weber to the deaf ear shows the absence of a traumatic labyrinthine lesion; the deafness is probably of old standing and is due to lesions of the middle ear.

(2) Recent perforation of the tympanic membrane from an explosion; Weber's test is lateralised to the good side; we conclude that the labyrinth has been injured at the same time as the membrane; prognosis with regard to the deafness is reserved.

If the Weber is lateralised to the injured side, the labyrinth has not been perceptibly affected ; and the prognosis with regard to function is more favourable.

(3) Recent concussion, with slight or no traces of injury to the right tympanic membrane ; marked unilateral deafness on the right side ; Weber localised decidedly to the left, sound side ; we conclude there is concussion of the right labyrinth. But how shall we check the patient's statements ? If he is not forewarned, Weber's test furnishes us with the means of entrapping him.

The tuning-fork is set vibrating on the vertex ; it is stated to be heard by the left (the sound) ear. I then stop up this left, sound ear ; the honest patient will declare that he hears it better than before ; the simulator, if *not forewarned*, declares that he no longer hears anything. Such a result is actually impossible, the bad faith will be evident even to the eyes of the layman.

HEARING FOR THE SPOKEN VOICE

Loud voice.—All the other hearing tests are in a way only the preliminaries for the medical report ; examination of the hearing power for the human voice constitutes, on the other hand, the chief part and alone dictates the conclusions.

In fact, what does hearing for the watch or the tuning-fork matter ? We must state whether the soldier hears well enough to understand orders, whether the injured man can communicate with his fellows and to what extent.

This test has already been roughly made at the beginning of the examination, and we will not revert

to the importance of the acquired results. We keep them in our memory when we are about to carry out the systematic investigation.

This test should not be carried out haphazard but according to a strictly regulated method.

We no longer ask the patient to answer the questions put to him or to execute orders. We ask him to repeat syllables or words; we shall in this way know with greater certainty whether he has really heard, and we can then recognise in a more exact way the defects of his hearing.

The voice employed is the ordinary conversational voice, well articulated. Those with extreme deafness require the shouted voice.

Unfortunately, the intensity and the ease of comprehension vary with each observer. There result, therefore, great digressions with the same patient, according to the examiners. This drawback, which is enormous in regard to scientific research, may be ignored in the case of medical reports for which approximate results are required. Although it would be dangerous to determine the effects of treatment of deafness by the distance at which the patient hears the loud voice of different persons before and after certain periods of such treatment, yet it is permissible to state that a soldier who can hear the loud voice of one of us at from 4 to 5 metres, is fit for combatant service.

The sounds uttered by the loud voice may be meaningless syllables, any chance words or words chosen beforehand.

The man to whom we are speaking not only listens with his ears but with his eyes and brain. These latter organs do not actually interfere if the

sounds reach the ear with sufficient force for it to register *all* of them without effort. But the sounds which make up human speech differ much in intensity ; an ear, interrogated to the extreme limit of its auditory power, perceives certain sounds, not others ; the patient, however, quite understands the word and the phrase in their entirety because he guesses what he does not hear, in the same way as we can reconstruct an inscription of which some letters are missing. In addition, the deaf man has unconsciously acquired the habit of watching his questioner ; he lip-reads some of the sounds that he does not hear ; the fact is an everyday occurrence ; a partially deaf man understands much less in the dark ; he likes to follow with his opera-glasses the movements of the faces of the actors.

We must, therefore, eliminate sight and intelligence in the scientific investigation of the deafness ; this is easily arrived at, in the first place by the respective positions of the doctor and patient, or better still by the closing of the patient's eyes, and in the second place by the utterance of disjointed syllables : lah, fah, vu, po, ba, etc. This is how professors of deaf-mutes proceed when they undertake the auditory re-education of a deaf subject.

This method further enables us to analyse the defects in the patient's hearing, and shows that certain sounds are in general better heard than others, thus furnishing the means of drawing-up tables of increasing difficulty.

But in spite of all these advantages, this method, so valuable for scientific research, is not suitable for examinations for actual medical reports ; it is not easy to get a deaf man or a simulator to repeat even

such words as he knows ; it would become a Herculean task if we tried to make him repeat disjointed syllables ; he only answers what he wishes and how he wishes ; we risk being led into the most fantastic results. Why ? Because all check is wanting, whereas you would be able to call your man quickly to a sense of the realities if he refused to repeat well-known words at a distance at which you know perfectly well that he understands the spoken voice.

We consider then that we must take care not to eliminate the rôle of the brain. Like Halphen¹ and many others we choose words most easily understood and guessed by all, such as numbers, for the results must be comparable the one with the other, and such words as "lambeau," "Vichy," etc., which seem to us familiar and easy to repeat, are for a peasant from the fields almost unused terms which he will hesitate to pronounce.

"Six," "Sixty-six," "Seventy-six," etc., will serve for measuring the audition for high-pitched sounds. "Forty-four," "Ninety-two," etc., for deep tones. The patient is seated at the end of a quiet and sufficiently long room, on the walls of which the yards or feet are marked off so that the distance between the examiner and the examinee can always be ascertained.

A trained nurse covers the patient's head with a cloth so that he may not know at what distance he is from the observer at the time of the examination ; she has an important work to do, namely that of closing the ear which is not being investigated ; the telephone *assourdisseur* is likely to deafen the two ears and to make an impression on the patient ; simple closure with the finger or cotton wool moistened

¹ *Des lésions traumatiques de l'oreille interne*, Thèse, Paris, 1910.

with glycerine is open to the greatest errors. We have recourse to a manœuvre which consists of rubbing the auricle of the ear with the palm of the flat hand. Anyone can try this mode of obliterating the hearing on himself to see how efficacious it is.

The observer, placed in a line with the auditory meatus of the patient who is seated sideways, repeats in a loud voice various numbers, while changing his position by retreating and advancing; but he walks noiselessly; thus, the injured man is quite ignorant of the distance at which the sound is emitted.

If he is in good faith, the test is easy to make; we note the maximum distance at which each group of numbers is heard clearly. If he is simulating, he finds himself in a very embarrassing position; he commences by repeating nothing; it is then that the attentive nurse puts on the psychological catch; she questions him; she explains to him how unlikely it is that he should have become suddenly quite deaf; he then consents to repeat what he hears, and the man who did not hear "three" or "four" at one yard begins to understand at five or six yards and more.¹



FIG. 19.—Position of the patient for the test of the loud voice.

¹ The deafening of one ear with the *assourdisseur* influences the other; we should stop it and be content with closing up the ear when the extreme distance of comprehension is arrived at, if we wish to obtain an exact measurement.

We have insisted on these apparently futile details, but they are very important for us; the medical report offers much less guarantee when the test of the voice has been practised with the patient's eyes open, for he will then himself measure his auditory power according to his own desires.

Whispered voice.—Investigation with the whispered voice presents a characteristic of preciseness which places it, from the scientific point of view, far above the practical investigation with the loud voice. We agree to this willingly. We register the results of this test with great interest in the case of a deaf man who is sincere; but we do not know how to eliminate deceit, and, practically speaking, the test is not of much value for a medical report; very few injured men consent to listen to the whispered voice, or they will perceive it only at a distance which they know to be very short, even when their eyes are closed. Nevertheless, the experiment will always be attempted; the residual air will be used according to the classical data; it is useless to dwell further on this. The ear not being examined is eliminated by simply stopping it up with the finger.

COCHLEAR REFLEXES

A. Cochleo-phonatory reflex. — *Lombard's Test.* — Everyone knows that extremely deaf men do not speak in a normal voice. All do not shout "like deaf men"; many even talk in a faint muffled voice with no ring in it. Not hearing themselves speak they have lost control of their vocal utterance; the same individual may begin a conversation in a very low

voice and an instant later shout noisily, quite unconsciously.

The normal man who desires to be understood by others, modulates his vocal intonation so as to hear himself speak ; we talk more loudly in a moving train than in a quiet place ; this adaptation is unconscious ; it is not a manifestation of will ; it is a reflex action.

The investigation of this reflex permits us, under certain conditions, to determine the auditory acuteness.

The classical authors contrast the normal voice of a really deaf man with that of the simulator which has not altered. But such an observation does not furnish precise data for a medical report.

The test suggested by Lombard is, on the other hand, productive of practical results. It is based on the following principle : total and sudden artificial deafening of both ears in a normal subject produces a sudden and unconscious raising of the speaking voice ; this voice-raising stops suddenly at the same time as the " deafening."

If this same manœuvre is performed in a case of extreme bilateral deafness with both labyrinths involved, no modification of voice is produced for the reason that we cannot " deafen " anyone who already hears nothing.

The noise-machine applied to one ear in a normal subject brings about only imperceptible raising of the voice, because the other ear is sufficient for the production of the reflex regulation of the voice.

In a case of unilateral labyrinthine deafness the application of the noise-machine to the good ear has the same result as when both ears are deafened in the normal person ; the patient finds himself suddenly

quite deaf and he shouts. Of course the application of the noise-machine to the deaf ear has no effect.

Lombard's apparatus is the ideal *assourdisseur*, or noise-machine, for this test. It consists of two

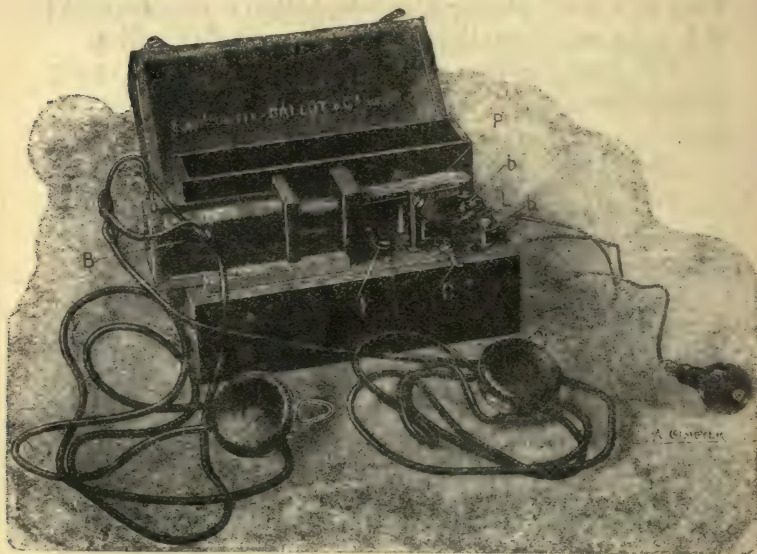


FIG. 20.—Dr. Lombard's *assourdisseur* (noise-machine or deafener) (Gallot & Co., makers).

bb'. Flexibles going to interrupting push-switch.

P. Pallet (interrupter).

L. Lever controlling the number and the amplitude of the oscillations of the pallet P.

C. Commutator closing the circuit of the battery on the inductor.

B. Induced coil, the power of which depends on the distance to which it is pushed on to the inductor.

telephone ear-pieces into which the current from an induction coil enters, an electric current having been thrown into this latter. Lombard's arrangement is

perfect ; some have given themselves the pleasure of varying it without improving it ; for our part we simplified it as far as possible in 1915 ; we connected our telephone ear-pieces directly to the two poles of the galvano-cautery of a Gaiffe transformer ; the apparatus thus constituted is adjustable ; it can be started and stopped suddenly, these actions being dependent on the interruption of the transformer. There is one indispensable precaution, namely, that the length of time of vibration should not be prolonged for fear of heating of the transformer. However, the noise produced is not so considerable as in Lombard's form, which is still the best.

The way of carrying out the experiment is of the simplest : the patient is seated ; the telephone ear-pieces are placed to the ears ; the patient begins to speak ; the current is started ; he either raises his voice or he does not do so ; the current is then cut off.

The experiment is all the more conclusive when the patient does not resist, and the more he is occupied by what he is saying the less he is on the defensive. The most favourable condition is obtained when the man relates the history of his campaign or recites something from memory ; the mental effort occupies him entirely, and he is in a state of inertia favourable to the production of the reflex ; if he will not narrate or recite we get him to read aloud ; the conditions are, however, not so good ; if we cannot get him to read fluently, we ask him to count ; every man knows how to count ; he must, however, count loudly, quickly, and without stopping on any pretext whatever.

This " deafening " process, much used by us, was

greatly dreaded by the exaggerators under our care ; they looked upon it as a veritable " Irish footpath " interposed in a series of obstacles to be overcome. They tried their best to avoid it.

Some flatly refused to submit to it ; they professed that the vibrations caused them an amount of discomfort which it was impossible to overcome. We, therefore, made a rule of practising the test very soon after the arrival of the injured men and in such a way that they were not prejudiced against it. Moreover, we recognise that the sudden use of the noise-machine to one ear or the two together may produce a disagreeable effect which explains why the patient who has not been warned stops speaking ; this " surprise " is especially painful to a man suffering from concussion, and its effect is shown by an odd inhibition ; one of our comrades suffering from concussion of one ear was " deafened " while he was reciting one of La Fontaine's fables ; when the noise-machine was applied to the good ear very marked voice raising was produced ; when applied to the affected ear which was only partially deaf, he experienced a disagreeable sensation as well as, at the same time, loss of memory, so that he could not remember the fable ; this disturbance only lasted an instant ; it is, therefore, indispensable to accustom the injured man to it before commencing the experiment ; the telephone ear-piece is applied while vibrating gently at first and then more loudly, and he is asked whether he can hear the noise produced as if his hearing were being tested ; he often confesses to hearing it very slightly and so does not refuse finally to tolerate it during phonation.

Certain subjects who are not deaf and are known to have good will, do not raise the voice while the

noise-machine is being used ; these are people who ordinarily speak in a dull toneless voice and who talk, as it were, within themselves ; we must ask them to make the necessary effort so that they can be heard by anyone a few yards away.

Others do not raise the voice because, being forewarned, they try with all their energy not to do so ; if we stop the noise-machine suddenly they lower the voice all at once ; the reflex has, therefore, acted ; it is proved that they hear themselves speak.

Again others do not raise the voice because they begin by shouting with all their might ; it is for us to discern whether this tone of voice is habitual to them or whether it is put on.

The " noise-machine " test when practised with care gives invaluable results ; it has the great advantage of being demonstrative even for the layman.

We must not expect more of it than it can give ; a subject whose cochlear and phonatory centres react in a normal manner may not have, for all that, perfect hearing ; he may even be dull of hearing, but he has not, to a certainty, a destructive lesion of the internal ear with extreme deafness. This test is of value for all alleged labyrinthine deafnesses due to direct or induced traumatism, to a projectile or a displacement of air, the most frequent cases for medical reports.

B. Cochleo-pupillary reflex—Halphen describes in his thesis Ostino's cochleo-pupillary reflex ; under the effect of perception of the tuning-fork the pupil narrows and then dilates. Halphen denies all practical value to this unreliable and generally feeble reflex, which cannot be determined without a special apparatus.

C. Cochleo - palpebral reflex. — Gault, head of an otological clinic, has drawn attention to this reflex which is much more reliable than the preceding one ; it depends on the fact that auditory perception of a sudden noise causes contraction of the orbicularis palpebrarum of the same side.¹

The subject is seated facing a window ; the observer places himself between the patient and the window in such a manner that the patient's face is well illuminated.

A *sudden* but slight noise is produced *unexpectedly* ; if heard it provokes a slight winking movement, chiefly disclosed by an examination of the tips of the eyelashes, truly a magnifying index to the palpebral movement.

¹ The cochleo-palpebral reflex has lately been the subject of numerous publications.

MOLINIÉ, who has described it very fully, considers it an exaggeration of the normal reflex of auditory accommodation. The normal route of this reflex which brings about contraction of the stapedius muscle follows the acoustic nerve, the cochlear nucleus of the bulb, the nucleus of the seventh pair and of the facial nerve. If the sonorous impression is severe, the motor excitation which it sets free and which is too intense to be confined by the few fibres going to the nerve of the stapedius, invades the neighbouring fibres and reaches with them the orbicular muscles of the eyelids. A still more intense sonorous excitation gives rise to contraction of different muscles of the face, the head, the nape of the neck, and even the whole body. Is it quite true that such an intense reaction can be the effect of a simple exaggeration of a reflex of auditory accommodation? We should rather consider the cochleo-palpebral reflex as a partial manifestation of a reflex of general defence of the organism which is observed to follow an *unexpected sensorial impression*, sonorous, luminous, tactile, etc. ; hence the importance of the element of surprise for the determination of the reflex.

Whatever be its nature, the contraction of the orbicular muscle of the eyelids indicates that the auditory impression has indeed been received and transmitted to the centres. As this impression has no other route of penetration except the auditory nerve the reactionary manifestations consecutive to the auditory impression are a witness to the anatomical functional integrity of the labyrinth and cochlear nerve. We have, therefore, in these provoked reflex manifestations, a means of investigating the auditory nerve (Molinié).

Simple clicking of the fingers is sufficient for a sound ear. We use louder and louder noises until the reflex is produced if the subject is partially deaf, using, for example, those produced by the blow of a key on a metal lid, or a bell, the ear not under examination having been carefully stopped up by a plug of cotton wool moistened with glycerine a few moments before starting the test for the reflex. But it must be remembered that the reflex will wear itself out ; it must only be provoked *once* at each examination and *always unexpectedly*, as, for example, during the objective examination.

We need not insist on the simplicity of such a test and on the evidence of its results.

It will become still more exact and more valuable when we possess an apparatus which produces an identical noise, accepted by all and graduated so as to fix the minimum of perception necessary to provoke the winking movement.¹

However, the rôle of surprise is such that there will be great advantage in the noise-producing apparatus being as simple as possible so as not to attract in any way the attention of the man under examination.

TESTS OF RELIABILITY

The notes of the hearing-power having been taken, we must draw our conclusions. We are not here making a scientific investigation but a medical report ; we must, before arriving at a conclusion, know how

¹ R. Foy has attempted this by modifying Lombard's apparatus, which he uses not as a deafener but as a source of sound (*Presse Médicale*, 1917).

to estimate the sincerity of the subject. Certain tests have already given us useful information from this point of view; they are, however, insufficient for difficult cases.

We will review the different problems which the expert must determine.

Deaf-mutism.—The man hears nothing; he does not speak; the making of a medical report is almost impossible; however, the cochleo-palpebral reflex here shows its great value. If this is preserved we shall then know that the deafness is of functional rather than organic origin.

Complete bilateral deafness.—The man speaks, but he does not hear.

Cases of total bilateral organic deafness due to a double labyrinthine lesion are very exceptional. We do not profess, however, to deny their existence.

Traumatic hysteria and simulation may have this same syndrome.¹

Simulation is really painful to an individual with any intelligence, unless he succeeds in making us believe that he has acquired lip-reading.

The *minus habens*, the illiterate, suffers much less from moral solitude; he also makes a greater stand against the expert examiner, the absence of means of communication between him and the examiner considerably reducing the range of tests.

The attitude of the subject under examination furnishes the first element for distinguishing between organic and functional deafness; we have described that of the hysterical man and simulator

¹ In this chapter on Medical Reports we do not distinguish true simulation from the unconscious simulation of the hysterical man; the means for the diagnosis have been set forth in the chapter on Simulation.

as being opposed to the habitual attitude of the really deaf.

We must not count on the supervision of male or female nurses for taking the simulator by surprise when in conversation with a comrade, for he mistrusts everyone and everything.

We shall on rare occasions succeed in convicting him by taking him by surprise ; bringing the examination abruptly to a close, we say suddenly in a natural voice, "Get up," "That's all"; he gets up and is detected ; or else we call him back unexpectedly, or let a piece of money fall on the ground, and he turns round. All this is, however, as a rule, useless trouble.

The surprise is greater if the attention is very quickly drawn towards a particular point.

Chavasse and Toubert stop examining their patient ; they undertake the treatment of the so-called deafness by catheterisation of the Eustachian tube. This little intervention tickles the pituitary membrane disagreeably ; at the time of the sitting the order to rise or turn the head is quietly given ; if this order is carried out it shows that hearing is preserved.

However, none of these means of estimation are equal to the cochleo-phonatory and the cochleo-palpebral reflexes. The latter is easily effected, but it must be sought for quite unexpectedly to the patient.

"Deafening" by means of the noise-machine sometimes presents, especially among those who are illiterate and "pretend to be idiots," so much difficulty that we hesitate about drawing a conclusion from it. When the test succeeds it is decisive.

There still remains an extreme measure which we have never had to employ, namely, to chloroform the patient and question him during the intoxication (Pasquier and Halphen). It would be less risky to surprise him in his sleep in the morning and to wake him up by speaking or the noise of ringing.

A new and valuable addition to these tests is furnished us by checking the lip-reading in injured men who understand this language.

We wish first of all to establish the fact that we believe in lip-reading on the part of totally deaf men. One of us (Bourgeois) was among the first (May, 1915) to introduce it into his department and to note some conclusive results. He has also seen some remarkable successes obtained by the professors of the Institution for Deaf-mutes in Paris.

It is the right of every deaf man that we should give him this important relief in his infirmity ; further, we owe it to the dull of hearing whom we have given up hope of improving. But this instruction is a double-edged weapon ; it constitutes, if we do not take care, a marvellous opportunity for the simulator. To feign total deafness is extremely painful for anyone who has the least intelligence. How agreeable and elegant it is for him to learn in a few weeks to converse as in the past with his fellows ! He is a marvellous subject, the pride of his professor whom he leaves with a discharge paper, adorned with a gratuity and universal admiration !

The possibility of such an abuse calls for serious checking which takes the form of a new test for the sincerity of the deaf men. This method had its origin in our clinic, having been invented by our collaborator Gosset, and, we may say, at our instigation, for we

have always manifested our astonishment at the rapidity and perfection of some of the successes. We have ourselves perfected this method of control.

M. Gosset's three experiments were published by him in the *Progrès médical* of Feb. 5, 1916.

The first is based on the fact that "ah" can be said with the lips in the position usual for articulating this vowel, but that it can be also emitted with almost any movement of the mouth and, to be particularly noted, that used for the sound "ē"; the normal positions for "ah" and "ē" are very different, of which anyone may assure himself if he tries it in front of a mirror.

We set about the test in the following manner:—

1st. By saying *ah*, *o*, *ā*, *ē* (English), *u* (French) in the usual way, the patient repeating the vowels as they are uttered.

2nd. By emitting the sound *ah* while articulating as for the sound *ē*.

The deaf man who reads *ē* repeats *ē*; if he is uncertain he hesitates and answers nothing; the simulator says *ah*; it is a simple and conclusive proof. That from all the vowels the subject should choose *ah* of which the articulation is so different from *e* is because he heard *ah*, in fact, because he could really hear.

The second test consists in emitting any vowel in a slightly raised tone, then more loudly, then very loudly. The deaf man who is guided only by the movement of the lips repeats in the same tone; the simulator, guided by his hearing, lowers and raises the tone as does the professor; this would certainly be a proof that he hears.

Lastly, Gosset articulates without emitting any

sound ; the deaf man reads and repeats ; the other remains silent.

This last experiment is less conclusive than the others, because we are not sure that the movements of the lips are absolutely identical when the sound is actually pronounced and when only articulated. The second test rarely succeeds. It



FIG. 21.

Normal emission of *ah*.

Emission of the sound *ah* while articulating *ē*.

is only necessary to be forewarned in order not to be entrapped by the first.

We have therefore had the idea of speaking while the patient's ears are deafened by the noise-machines ; if he is deaf and lip-reads he should continue to understand ; if he is deceiving us, he will no longer understand.

There is the objection that the noise-machines may worry the man to the extent of occupying the attention required for lip-reading, and we have modified the experiment by speaking in a very low voice,

the ears being carefully stopped up with cotton-wool moistened with glycerine, which is pressed on by the fingers of an assistant.

We proceed as follows : We begin by approaching our patient in a friendly manner, stating openly that he understands us perfectly. We stop up his ears and speak in a low voice ; if he is silent, he is caught. The following is a pitfall to be avoided : any stranger who questions a deaf man will put one or several of the following questions : “ Are you married ? Where do you live ? Have you any children ? Which is your regiment ? How were you wounded ? ” Without being very well up in lip-reading our man can guess the words “ country, children,” etc. We must show a little imagination and put simple but more unexpected questions.

Can it be proved in a more striking manner that the man hears and does not lip-read and that he is even able to understand the spoken voice when very slightly raised ?

Extreme bilateral dulness of hearing.—What we have just said with regard to total deafness applies equally well to extreme deafness in which the injured man only perceives the loud voice on close contact with the ear.

The problem is a different one when the spoken voice is heard a short distance away. The watch is not heard, and we cannot check this. Tuning-forks are not perceived at all by air- or bone-conduction, which is very suspicious, or they are only heard slightly, unequally or paradoxically so that the results cannot be registered with any confidence when the patient exaggerates.

The test of the spoken voice with the eyes shut

furnishes quite conclusive information according as to whether the man is sincere and always answers when spoken to a short distance away, or is deceiving us and makes wild mistakes beyond all probability.

This test is not practicable if the voice ceases to be heard beyond a few centimetres. Hearing-tubes then come into use.

A man who hears at a short distance away will



FIG. 22.—The two tubes are held by an assistant without the simulator believing he is being

hear through the hearing-tube; if he refuses to do so it will show his bad faith.

If he consents to it, we set the trap of speaking to him across a closed tube; the sonorous vibrations then pass through the air and the auditory meatus which is incompletely blocked up by the tip of the tube; we can thus estimate whether the voice is or is not heard at about 1 metre instead of at the few centimetres previously obtained.

We proceed differently but on the same principle. The patient has a tube in each ear. He turns his

back to us and closes his eyes ; without his knowledge an assistant, and not the observer, holds the tubes. The observer speaks while stepping back by degrees 1, 2, 3 or 4 metres, the deaf man still answering. He is caught in the very act. This method has often succeeded with us. We specially recommend it.

We check the lip-reading if the man concerned professes to understand by this means alone ; but



patient's knowledge. The observer speaks at some distance away spoken to through the tube, hears and repeats.

here we must be on our guard. We know, in fact, that the eyes furnish for the individual of good faith marked assistance when he is at such a limited distance away that he can understand with his ears certain syllables and vowels though not all the sounds which compose speech ; we must, therefore, not be in too great a hurry to conclude that the case is one of simulation.

The tests for the reflexes maintain their value ; the noise-machine test informs us as to the absence of an important lesion of the internal ears when normal

voice-raising is produced; simulation is plainly indicated when the patient who is really deaf in one ear pretends not to hear with the other, for the use of the noise-machine to the two ears separately gives clearly contrary results.

Total unilateral deafness.—Simulation of unilateral deafness is the easiest to detect. The means are not wanting. We have seen that the "false" Rinne of Lermoyez and Hautant constitutes a proof of sincerity. We must remember of what it consists; the patient, totally deaf in one ear, nevertheless perceives the sound of a vibrating tuning-fork on the mastoid of that side; this is only apparent, the sound being perceived not by the affected ear but by the good one.

The simulator, on the contrary, having decided to hear nothing with the would-be deaf ear, acknowledges no perception of sound.

Weber's modified test gives conclusive results in patients who have not been forewarned; we will recall it. The patient perceives the tuning-fork on the vertex in the good ear; if we close the meatus of that ear he says he no longer hears anything, an evident untruth, for the auditory sensation has not been suppressed but rather reinforced.

Stoppage of the meatus with the finger is not sufficient to prevent the spoken voice from being understood. We should strongly suspect the good faith of a man who ceased to repeat what was said to him when this simple means was employed. It is equally very suspicious if the high-pitched tuning-fork c^2 (ut^4) set vibrating in front of the ear said to be deaf, is not heard, for under these conditions it should be perceived with the opposite ear.

A great number of experiments are based on the following principle : we speak alternately and very quickly in one or other ear through a speaking-tube or telephone ; the subject should repeat as soon as he hears ; he has to pay great attention so as not to become careless and repeat once or twice what is said into the ear which he pretends is deaf ; he would in such a case be indisputably convicted of fraud. This experiment rarely succeeds, for the patient soon becomes able to bring it to a deadlock by answering with prudent slowness ; it deserves, however, that we should devote to it these few words of description borrowed from Halphen's thesis :—

Lucæ speaks alternately into two hearing trumpets connected to the two ears. The patient has his back turned. He will answer the question or hesitate. The hearing person cannot make a mistake.¹

Kern has the same phrase pronounced by two different examiners through two speaking-tubes attached to the auricles. The one speaking to the affected ear leaves out something. If the patient repeats the phrase with the omission it shows that he has heard with the deaf ear.

Muller has two absolutely different phrases pronounced close to each other. The injured man who is deaf in one ear will only repeat the sentence spoken in front of the good ear. The simulator is embarrassed ; he hesitates and makes mistakes. This test would seem to be conclusive only if the telephone is used so as to prevent the two phrases reaching the healthy ear.

¹ The tubes must be very long so that the observer can go far off, without which he will always be heard by the good ear even when he speaks into the tube leading to the ear said to be deaf. This cause of error gives rise to serious mistakes, and this test is a particularly poor one.

Stenger has invented an experiment established on quite a different principle. Let us suppose there is deafness of the left ear; we find at what distance a certain tuning-fork is heard by the right ear; we now set an identical tuning-fork vibrating immediately in front of the deaf ear. If we then bring the first tuning-fork to the good ear it will be still perceived at the distance first noted if the left ear is really deaf, and at the same distance from the right ear as the one vibrating in front of the left ear, if the left ear hears this tuning-fork.

What takes place?

(1) If the left ear is *deaf* it does not hear the tuning-fork on its side; its presence does not modify the perception of the right ear, which always hears its own tuning-fork at the same distance.

(2) If the left ear *hears* the noise of its tuning-fork, when it is brought closer it covers the sound of the right side tuning-fork which the patient no longer hears; the two tuning-forks are only heard together when their intensity, that is to say their distance, is the same on both sides.

Escat's *test with unisonant tuning-forks* is different, though based on the same principle:—"When the two ears of a normal person are submitted simultaneously and respectively to the influence of two sonorous sources of the same pitch and quality but of different intensity, the perception of the resulting unison is lateralised entirely in the ear submitted to the more intense of the two sources, whilst the ear submitted to the less intense sound seems to receive no impression" (Escat).

Escat uses two tuning-forks a^1 (la^3 ; 435 D.V.) of the same pitch and quality, but of different size and

consequently different intensity ; one in fact weighs 305 grammes and vibrates for 180 seconds ; the other lighter one, 37 grammes vibrating for 70 seconds.

The test properly so-called consists of three stages :—

First stage.—The small tuning-fork, vibrating feebly but sufficiently to be observed by a normal ear, is held in front of the left ear which is supposed to be deaf, two centimetres from the meatus ; whether deaf or simulating the man under examination answers, “ *I do not hear it.*”

Second stage.—Immediately this same tuning-fork is placed two centimetres from the right ear ; whether deaf or simulating he answers, “ *I hear it.*”

Third stage.—While the small tuning-fork is vibrating in front of the right ear, we bring the large tuning-fork, vibrating strongly, in front of the left ear.

On being asked which side he hears it the deaf man answers that he hears it on the right side, which explains perfectly that his left ear really hears nothing.

The simulator may give two answers : “ *I hear nothing,*” or, “ *I hear on the right side.*”

In the first case he is clearly simulating, for if his left ear is really deaf there is nothing to prevent his hearing the small tuning-fork with the right ear.

In the second case the test is indecisive ; we must have recourse to the counter-test. For this it is sufficient, the large tuning-fork being kept in front of the left ear (supposed to be deaf), to withdraw the small tuning-fork from the right ear or to stop the vibrations with the fingers.

To the examiner’s question, “ Which side do you hear it ? ” the simulator nearly always answers, “ *I*

hear it on the right side." The deceit is evident; hearing it all the time on the left side he did not perceive the suppression of the small tuning-fork on the right side.

These experiments with the tuning-fork are attractive from the scientific point of view. They are

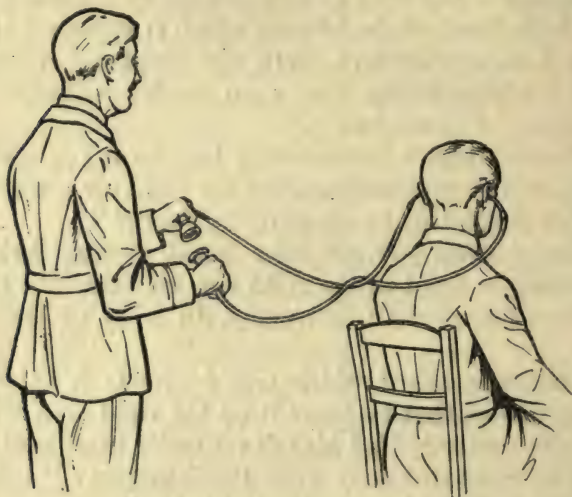


FIG. 23.—Bourgeois' test.

The subject acknowledges that he hears with the right ear. He simulates deafness of the left side. In the *first stage* the observer does not speak through any tube; the subject repeats what he hears.

probably of little practical value from the point of view of the medical report by reason of the extreme difficulty often experienced in interpreting the answers of the patients.

Without thinking either of Stenger or Escat, one of us (Bourgeois) formulated an analogous test much

more simple and demonstrative to the eyes of the layman.

This test of the hearing-tubes is based on the following principle (it was brought forward in a Discussion in Nov. 1915) :—

The injured man who simulates a unilateral deafness declares his inability to hear the voice when it is spoken loudly into the ear which he pretends is deaf, while the circumstances of the experiment are such that he could not have failed to hear it with the good ear.

The experiment can be made in two ways :—

(1) Let us suppose that the injured man acknowledges good hearing in the right ear and extreme deafness in the left one. He is seated with his back turned towards the observer, the end of a hearing-tube being placed in each ear; the two tubes are rolled one over the other, a very important precaution, so that he does not guess from the movements of the tube which ear is being spoken into.

Stopping up of the auditory meatus by the hearing tube is quite insufficient to hinder the perception of the voice, even when whispered, by the good ear. Therefore, we speak in the ordinary or whispered voice but not through the hearing-tubes, the mouths of which are directed downward; we then utter a number of figures which the subject hears with his good ear and repeats immediately; suddenly we bring the hearing-tube of the affected ear a few centimetres from the lips; at that moment the man declares he hears nothing more; he is silent. We may conclude from this test not only that the ear said to be deaf is not really so, but that it hears by the tube the whispered or the ordinary voice, whichever we use.

(2) We have made the test in another way : We begin by speaking in a low voice through the hearing-tube on the side of the ear said to be deaf ; the subject does not hear it : we gradually raise the voice until the loud and even the shouted voice is reached ; the patient still does not repeat what we



FIG. 24.—Bourgeois' Test.

Second Stage : the observer speaks in the tube on the left side ; the subject is silent ; however, he ought to hear it all the time, at any rate with the right ear.

say ; nevertheless, he must have heard, if only with the good ear.

It is easy to explain the silence of a simulator by practising the experiment on ourselves ; if we place ourselves under the conditions necessary for its performance we shall see that the sound seems only to arrive on the side on which the hearing-tube conducts it to

the ear ; the other ear to which the sound arrives simply by the air seems to receive no impression whatever, as though it were put completely out of the reckoning. A patient who is really deaf in the ear into which we speak through the hearing-tube, hearing nothing by this ear, continues to perceive the sound by the other and repeats as if we had not spoken through the tube. A normal and sincere person hears very loudly through the tube and repeats what he hears ; if normal, but a simulator, he finds himself suddenly only able to hear with the ear which he pretends is deaf ; he naturally thinks that this is the only ear being tested, and is silent.

We have made this experiment on sincere subjects and on undoubted exaggerators ; it has given us very convincing results. It is easy to carry out even for those who are not versed in Otology.

CHAPTER IV

FUNCTIONAL EXAMINATION OF EQUILIBRIUM

Preliminary examination.—The consideration of the former histories of which we have spoken in a previous chapter, will have already given us information in regard to disturbances of equilibrium which may have shown themselves from the first moments of the accident. This history is of importance, for it is not very likely that marked disturbances will be present at the time of the examination for the medical report, when the injured man has not presented serious perturbations of equilibrium during the days following the injury. Experience has, in fact, taught us that vertiginous phenomena secondary to labyrinthine injury are generally of relatively great intensity at first, but that they decrease subsequently.

We should also take note of the man's appearance on the day of his arrival, how he habitually goes to and fro after his arrival in the hospital, so as to be able to compare his ordinary manner with the disturbances he may complain of during the examination.

The questioning bears not only on the past but on the present; it is very important to find out exactly the frequency, the intensity and the modality of the vertiginous attacks. Vertigo is a sensation

so painful, so agonising and so impressing even in abortive cases, that patients always find descriptive expressions exact and vivid enough to depict it in such a manner that we readily believe in their sincerity. The simulator, on the contrary, does not know how to explain exactly the sensations which precede the attack, its horrors, its frequency or its duration.

The examination properly so-called, as in the case of the hearing, deals with two orders of phenomena : some are to a certain extent voluntary, as walking and standing upright ; others are independent of the will, such as Barany's reflexes and Babinski's electric reactions.

Investigation of the equilibrium when standing upright and walking.—Equilibrial disturbances of labyrinthine origin obey Romberg's law, that is to say they are greatly increased by closing the eyes. Sight, it has been said, acts as a "crutch" to the sense of attitude. Thanks to it the patient can correct the erroneous impulses from his internal ear and the disturbance of equilibrium is diminished ; without sight he is indefensibly at the mercy of his labyrinth and he totters.

Standing upright.—For the purpose of investigating the equilibrium in the standing upright position, the man holds himself straight up, the feet near each other, and not with the heels together.

We ascertain whether there is normal equilibrium, tottering or a tendency to fall. The latter always takes place in the same direction, in general to the side of the affected labyrinth, or, in a bilateral lesion, to that of the most affected, but it varies according to the position of the head, that is to say of the labyrinth in relation to the body. Should there be a

lesion of the right labyrinth, the body remaining stationary we turn the head 90° towards the right; the tendency to fall is no longer to the right but backwards; in fact the injured labyrinth has become posterior in position. If we now displace the head towards the left the tendency is to fall forwards.

This variation of the tendency to fall according to the position of the head in relation to the trunk is of great importance, for it indicates that the lesion is labyrinthine and not cerebellar, in the latter case the direction of the falling being the same whatever the position of the head.

We then perform the same experiment, the patient standing on one leg; after this we begin all over again, the patient having his eyes shut.

Walking with the eyes open.—Walking with the eyes open may be normal in spite of a vestibular lesion. The more marked cases will show a slight lateral inclination, in still more pronounced cases the classic staggering called “duck’s walk,” reeling like a drunken man, with the legs apart; finally when of a still greater degree the patient falls after going a few steps, in the ordinary course of things always in the same direction.

Walking with the eyes shut. Babinski-Weil’s test.—We have kept till the end *walking with the eyes shut* because it is the most delicate test, the one which detects the slightest equilibrial disturbances and which indicates most precisely the direction of the pathological impulse in the mild cases most often met with by the expert. Cestan’s ¹ communication has shown us the fundamental importance of this test when applied according to the Babinski-Weil method.

¹ *Soc. Méd. des Hôp.*, 1916.

The experiment is made in a room five or six yards in length and at least four wide, in which the subject can turn round without knocking against anything. He is placed with his eyes shut at one end of the room, exactly in the centre; he is ordered to walk across its whole length, advancing and retreating without opening the eyes and without stopping; the observer must prevent him from knocking against obstacles; we make him walk forwards and backwards thus ten times.

A normal subject will hardly deviate at all and certainly not always in the same direction; we do not count as pathological deviation the changes of direction due to an accidental irregularity in starting, to hesitation or a momentary false step.

The man whose labyrinth is affected, on the contrary, nearly always deviates in a very particular way. When he walks forwards he inclines constantly and almost regularly towards one side, say to the right; in the backward walk he inclines in the opposite direction, to the left in the present case, so much so that after a certain time he can be seen to walk in a line at right angles to the original direction and may even finish by going in an opposite direction to that in which he started off.

Not only is this test very delicate, but it can certainly never be simulated by a patient unacquainted with it, whilst staggering, tottering, balancing on one foot or on two are more under the control of all.

Cestan, Sauvage and Descomps have been desirous of making the test still more delicate by rendering the patient more sensitive by turning him round once with the eyes shut. We must, however, remember that this action is not without an effect; it excites the

labyrinth, tending to create an impulse towards a certain side; if the patient turns from left to right he is carried towards the right; consequently this

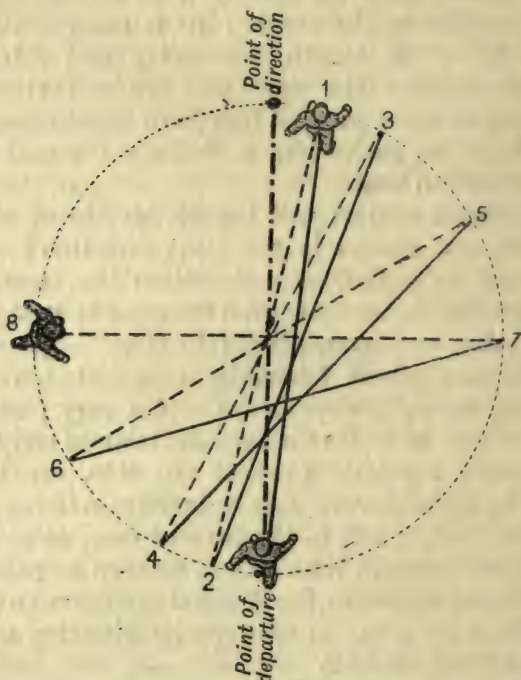


FIG. 25.—Babinski-Weil's test.

The subject deviates to the right in advancing, to the left in retreating. After going to and fro several times he follows a direction perpendicular to the initial one. The plain lines indicate the walking forward, the dotted ones the walking backward.

rotation towards the right will render him more sensitive to a spontaneous impulse to the right, but it might combat to a certain extent a spontaneous impulse to the left.

Consequently if we wish to make the experiment in this way, it must be practised twice, first after a turn to the right and then after a turn to the left.

Search for spontaneous nystagmus.—Spontaneous nystagmus usually accompanies an intense and relatively recent labyrinthine lesion; it indicates irritation of the vestibular nerve-endings and varies accordingly.

In the course of a vestibular lesion at its full height the nystagmus is easily disclosed during direct vision, the patient looking straight in front of him; but as the irritation of the nerve diminishes, on account of its cure or its destruction, the equilibrium of the eyeballs tends to become re-established; the nystagmus is then only perceptible during oblique vision, and soon even disappears.¹

Associated with the other elements of the vestibular syndrome, namely equilibrial disturbances and vertigo, this symptom is of great importance; it is then of interest to note it carefully on the observation sheet, describing its characteristics, its direction to the right or left, its horizontal or rotary nature, its course. But it is of no interest to us when it occurs quite by itself; it then becomes an ordinary symptom of divers nervous or ocular affections (Hautant).

Induced nystagmus.—Barany's tests.—We shall now, by artificial excitation of each vestibule,

¹ Nystagmus consists of two distinct movements: one which is hardly perceptible draws the eyeball gently in one direction; this is the slow movement. The other, a quick reactionary movement in the opposite direction, constitutes the more easily visible rapid movement; in practice the latter direction designates that of the nystagmus. Further, according as the eyeballs are displaced following a horizontal line or in a vertico-frontal circle, the nystagmus is called "horizontal" or "rotary."

estimate its reaction, from lateral deviation of the trunk and limbs to the appearance of nystagmus and the complete labyrinthine syndrome, *i.e.* vertigo and vomiting; as a matter of fact, we do not voluntarily go as far as to provoke these labyrinthine symptoms, for the expert should avoid all specially disagreeable manœuvres except those absolutely necessary, both in the interest of the medical report and in order to insure the good will of the subject.

Provoked nystagmus constitutes the fundamental symptom of Barany's tests ¹ which are at the present time classical; it presents the valuable advantage of being subject to a measurement which can be put down in figures; it can be calculated by its duration in seconds, this duration being directly proportional to the excitability of the organ examined. We must not be misled with regard to the relative value of the figures obtained or give to the results of the experiment a precision contrary to reality; it is important to consider the figures, but we must only take into consideration *great* differences between one subject and another; the duration of so-called

¹ The physiological basis of Barany's tests is as follows: *all provoked movement* of the endolymph in a semi-circular canal excites the vestibular nerve endings, chiefly in the ampulla, and determines the production of nystagmus which presents the two following characteristics:—

1st. It is directed in the plane of the excited semi-circular canal, that is to say, excitation of the horizontal canal gives a horizontal nystagmus, excitation of the vertical canal a rotary nystagmus.

2nd. The slow movement of the nystagmus is in the same direction as the endolymph moving in the excited semi-circular canal. The quick movement, that which in practice characterises the nystagmus, is then *in the opposite direction to the endolymphatic current*. We must always have these two principles in mind in the course of our vestibular examination. (See *Précis de pathologie chirurgicale*, Vol. II. Bourgeois, *Troubles de la fonction d'équilibration*, p. 91.)

“normal” nystagmus for each test is only approximate, and only when it differs considerably must it be looked upon as pathological; it is not rare to find great differences in the figures on the report sheets of the same subject, put down by successive observers; the differences between the two ears of the same person are more significant, especially if they are reproduced regularly in two or three repetitions of the test. Whichever it is, this possibility of measuring provoked nystagmus is of so much advantage that making the test should not be long delayed.

We must, however, know how to do without it; it has seemed to us impossible to note movement of the eyeballs in intractable, timid or unintelligent subjects; they refuse to put their eyes in the required position; they blink; they stiffen themselves; they interrupt the flow of the water; briefly, it is better with such to be content to study the deviation in walking and the movements of the upper extremities. Galvanic electrification according to Babinski is very painful if carried to the extent of producing nystagmus; we shall content ourselves with the deviation of the head and trunk.

1. Rotation test.—The man under examination is seated in a special armchair having a crank by which it can be turned round, or, more simple still, a swing the cords of which are wound round each other ten times.

He sits straight up, his head bent slightly forward. He has put on him a pair of spectacles, the ground glass of which prevents him from fixing his eyes which are open, on one particular point; in this way the movement of the eyeballs is uninfluenced.

If the right posterior labyrinth is the one to be

tested we set the chair rotating with a regular movement from the patient's *right to his left*; the speed is regulated so as to make ten turns in 20 seconds; the chair is then stopped suddenly.

Result in a normal person.—The subject looks straight in front of him into space, strong horizontal nystagmic movements *to the right* are seen; they gradually become less, the duration being from 25 to 30 seconds.

At the same time we shall notice that there is a tendency to fall *to the left* when in Romberg's position, and an inclination *to the left* when walking with the eyes shut.

If we ask him to lift up his two arms in front perpendicularly to the body, the eyes being shut, then deviation *towards the left* will be noted.

The subject is seated in front of us, the eyes open at first, then shut, and we ask him to touch alternately our knee and index finger which is raised to the level of our chest; he carries out the movement correctly whilst he can see and deviates to the left when he shuts his eyes.

Therefore, with nystagmus to the right there is deviation of the body and limbs to the left.

This contradiction explains itself, since the nystagmus to the right corresponds to the quick movement destined to correct the slow movement to the left; it is this slow contraction which is directly caused by the vestibular excitation, but as the nystagmus is named according to the quick movement we call it the opposite.

In reality the vestibular apparatus has been set in motion towards the left; on the sudden stopping the semi-circular canals have become stationary, the

endolymph has kept on moving and has caused an inclination of the eyeballs towards the left (slow contraction, the opposite to the nystagmus), as also of the walking with the eyes shut, the body in Romberg's position, the arms, the index finger.

To examine the left vestibule we turn him from left to right ; the results are exactly opposite.

Results in a pathological condition.—As with all reflexes Barany's can be exaggerated or diminished.

Exaggeration.—Exaggeration is shown by a longer period of duration of the nystagmus, but above all by exaggeration of the phenomena of deviation which may go as far as falling down suddenly and the occurrence of intense vertigo accompanied by pallor, cold sweating, nausea and even vomiting.

This exaggeration does not positively reveal a pathological condition ; certain people, otherwise quite healthy, have labyrinths more easily excited than those of others, and it does not denote disease if they are unable to waltz or turn on a "round-about."

A momentary state of nervousness or of irritable weakness may perhaps produce hyperexcitability of the labyrinth. In any case this happens sometimes in men who have been concussed ; we readily connect it with auditory hyperæsthesia which is so frequently present. Hyperexcitability when marked constitutes a presumptive symptom in favour of the reality of the concussion ; it indicates further a favourable prognosis. Any serious lesion of the vestibule causes hypoexcitability.

Diminution or abolition of the reflex.—Let us suppose in the first place that there is a bilateral lesion ; if *total* it involves *the absence of all reaction* ; there is no nystagmus or equilibrial disturbance, no

deviation on walking and in the movements after rotation ; if *partial*, diminution or absence of nystagmus may be noted, but the persistence of disturbances of equilibrium in walking and other movements.



FIG. 26.—Barany's rotation test (10 turns in 20 seconds). Post-rotation nystagmus in the opposite direction to the movement of rotation.

Let us suppose there is a lesion of the right vestibule, for example.

We commence by turning our subject from left to right, that is to say we excite his healthy labyrinth. We register almost normal results, though slightly lowered ; nystagmus to the left for 20",

leaning to one side, deviation in walking and in movements of the limbs to the right.

We then wait a few minutes and recommence the test in the opposite direction, from right to left, in order to excite the right labyrinth which is supposed to have been destroyed. On finishing the ten turns we stop suddenly and we may note horizontal nystagmus directed towards the right ear; the nystagmus is feeble and lasts only a few seconds, but it is well marked. The inclination of the trunk, deviation of walking and movements to the left, but in a much less marked degree than after testing the left labyrinth, are to be found.¹

¹ How is it to be explained that excitation of a destroyed vestibule may still give rise to reflex movements?

It is because, in reality, rotation in one direction or another tests the two vestibules at the same time, though to an unequal degree.

Let us consider the diagram, Fig. 27, which represents the two

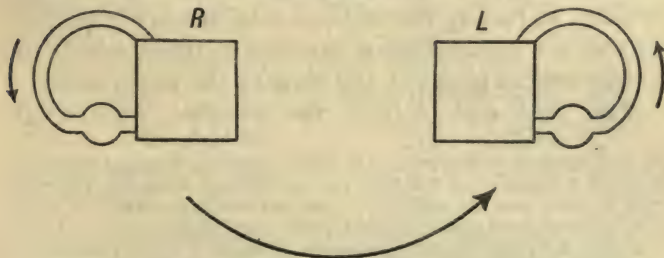


FIG. 27.

vestibules and the corresponding horizontal semi-circular canals of a normal subject; when we impart to the two a movement of rotation from right to left it produces, on stoppage, in the interior of the two canals, a movement of the endolymph in the direction of the arrow.

It is admitted that on the right side the fluid reaches the ampulla and attacks some excitable nerve-endings after having traversed the whole extent of the canal and with a speed greater than that on the left side where the ampulla received the fluid immediately after its exit from the vestibule. Whether this is the real reason or

Failing the swing or revolving chair this test may be practised by making the patient turn round on himself five times (Grivot) or round a stick as the centre (Moure).

Excitation thus produced does not always bring about nystagmus, but it acts sufficiently well on the equilibrium in the upright standing position and in walking to give a useful indication. Grivot has proposed an interesting chart for writing down the intensity of the deviation.¹

Caloric test.—Barany has contrived a means of provoking nystagmus by the application of cold or heat to the middle ear, and through it to the semi-circular canals. He believes he can in this way give rise to a current in a vertical direction in the endolymph, the cooled particles sinking and the heated ones rising, as actually takes place in a thermosiphon. In reality the facts do conform to the theory; the excited semi-circular canals are those which are in the vertical plane at the time of the experiment.

This test differs from the rotation one in the

not, the respective excitations of each labyrinth brought about by the same movement of rotation are of unequal intensity, the right being in this case the strongest, but the reflex movements which we note correspond to the sum of the two excitations.

If the duration of the nystagmus furnished by the excitation of the right vestibule is represented as 20'' and that furnished by the left labyrinth as 10'', the figures are reversed if the rotation is from left to right; in the two cases the sum of the two excitations gives a provoked nystagmus equal to 30''.

If our right vestibule is destroyed it becomes inexcitable and its contribution to the nystagmus=0. Rotation from right to left gives $0 + 10'' = 10''$.

Rotation from left to right gives $20'' + 0 = 20''$.

Thus, what we must consider when arriving at the result is not so much the actual value of the duration of the reactional phenomena and in particular the nystagmus, as the difference between the results obtained by rotation in the two directions.

¹ *Paris médicale*, 1916.

manner in which the endolymph is set in motion; and apart from this the results are identical. But the two ears are here investigated separately, which is a great advantage; the same is not the case with rotation.

Instruments required.—(1) *Barany* used to employ some kind of douche, ground-glass spectacles for the subject's eyes (this latter may be omitted), a stop-watch and water at 27°C . (80.6°F .), which may be cooled down to 20°C . (68°F .) if the reflex is not very active. The principle consists in watching for the appearance of nystagmus and of measuring the duration of the incubation period in seconds.

Brünings prefers to measure the quantity of liquid necessary for producing the reflex, and this is more convenient.

His *oto-calorimeter* is composed of a bottle furnished with a thermometer and a tap; the water which runs from it is conducted to the tympanic membrane by an



FIG. 28.—Barany's caloric test with Brünings' apparatus.

indiarubber tube at the end of which is an aural cannula made for a double current ; this cannula exactly fills the auditory meatus ; at its outlet a second tube conducts the water to a graduated glass vessel situated below the level of the ear which is being tested. The bottle and graduated glass are placed

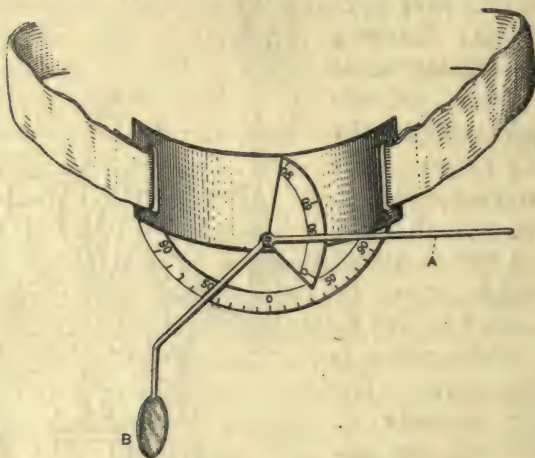


FIG. 29.—Brünings' Oto-goniometer.

A. Mobile indicating rod which must be placed on the figure 30 of the vertical dial. It indicates the direction of the horizontal canal.

B. Mirror, the rod of which should be on a level with the figure 50 on the horizontal dial.

on a board fixed to the wall. The water used is at 27°C . (80.6°F .), or at 20°C . (68°F .). Brünings has proposed, moreover, exciting the horizontal canal which is the most easily influenced by differences of temperature on account of its being external ; it is sufficient to place the subject's head in such a position as to render the horizontal canal vertical

(bent back through an angle of sixty degrees); the oto-goniometer enables us to be sure that it is in such a position.

The *oto-goniometer* is a little metal plate having on its anterior surface 2 segments of a dial; a band of woven material going round the head maintains it on the forehead.

On the right side of the vertical dial, graduated from 0 to 90° is a movable rod; on the horizontal one there moves a rod ending in a little mirror on which the man under examination fixes his eyes during the test.

Objective examination beforehand.—An ear must not be irrigated before we are sure there is no obstacle in the meatus, cerumen or anything else, which would hinder the access of the water to the tympanic membrane. The extreme congestion which accompanies acute otitis is opposed to the production of caloric nystagmus; the absence of nystagmus in such a case has no significance. The presence of a large dry perforation of the tympanic membrane exposes the tympanic cavity to re-infection even when the operations are carried out according to the rules of asepsis; and if asepsis is possible with the douche syringe, it is not so with Brünings' apparatus. It is preferable in such a case to replace the water by cold air. Dundas Grant has invented a very practical instrument which will be described later on.

A large perforation with suppuration is not a contra-indication, but the water goes directly on to the labyrinthine wall of the tympanic cavity and the effect of the cold is much more pronounced; this must not be lost sight of when calculating the effects produced.

Barany's technique.—The subject is seated, the head in the upright position ; one ear is irrigated with the hydrostatic douche containing water at 27° C. (80.6° F.) ; the watch is set going and the appearance of nystagmus watched for either while the patient is looking through the ground-glass spectacles or fixing his eyes on the finger placed 25 cm. in the direction of the expected nystagmus ; the time necessary for the appearance of the nystagmus is noted ; we then continue to watch the nystagmus to note its duration.

Immediately after its appearance we make the patient walk with the eyes shut to see if he deviates in one direction or the other. If the reflex is only slightly active with water at 27° C. the experiment is repeated with water at 20° C. or even 15° C. (59° F.).

When the test is practised in this way, it is the fluid in the vertical canals which is set in motion ; on account of the position of the head, the nystagmus is rotary and directed to the side opposite to the irrigated ear.

Brünings' technique.—This is a quantitative method ; in order to be able to compare the results obtained for each ear and each individual, Brünings endeavours to operate under the most favorable conditions which are always identical. The horizontal semi-circular canal being the most external and the one most easily excited, he tests this one by putting the head in a certain " optimum " position and causing the patient to fix his eyes obliquely at a certain degree, favourable conditions for the production and measurement of the nystagmic reflex.

This " optimum " position is realised by two movements :—

(1) The head is inclined 60° backwards ; the

external semi-circular canal normally inclined 30° downwards, becomes vertical.

(2) The head being in the first position, we incline it 45° towards the *side which is being irrigated*; the horizontal semi-circular canal is then in the most favourable position; for a given quantity of water the reflex is twice as strong as when the head is in the first position.

The patient under examination is seated with the head upright; we begin by fixing on his forehead the oto-goniometer; we place the movable indicating rod on the vertical dial at the graduation 30° . When in this position it indicates the direction of the external semi-circular canal. With regard to the rod with the mirror at its end, it is pushed in the direction of the expected nystagmus to the division 50° on the horizontal dial.

The head is then bent backwards till the first rod becomes vertical; then 45° to the side to be irrigated; we order the patient to fix his eyes in the little mirror. We irrigate the ear while exercising on the auricle gentle traction upwards and outwards to straighten the auditory meatus; we watch for the appearance of nystagmus and at the first jerks stop the irrigation. We then read on the graduated glass the quantity of water which has passed into it; we order the man under examination to get up and note whether or not there is deviation on walking and of the movements.

Dundas Grant's technique.—It is reserved for cases in which there exists a dry perforation of the tympanic membrane. The apparatus consists of a tube of copper, coiled in a spiral and covered by an absorbent material. One of the ends fits into the ear under

examination; the other is connected to a thermo-cautery bellows.

Immediately before the test is started the jet from a flask of chloride of ethyl is directed on to the spiral apparatus for fifteen seconds; the coldness obtained by the evaporation lasts for seventy-five seconds. In normal cases provoked nystagmus appears after inflation for thirty seconds.

The hot-water test.—The heat-test is less employed



FIG. 30.—Dundas Grant's apparatus for the cold-air test.

than the cold, for it is less powerful; the water injected must not be above from 40° to 42° C. (104° to 107.6° F.).

The manner of using it is the same as that described for cold water; the results are opposite, that is to say the nystagmus is towards the irrigated ear and the deviation of movements to the opposite side.

We only advise its use in cases of spontaneous nystagmus towards the ear which is not being irrigated;

cold water would only exaggerate the symptom; warm water, on the contrary, will provoke an opposite nystagmus to the first, and this will render the action of the reflex more evident.

Results in cases with normal labyrinths.—With Barany's method and water at 27° C. nystagmus appears after 35 or 40 seconds of irrigation; it is rotary and directed to the side of the non-irrigated ear; it sometimes persists for a hundred seconds.

With Brünings' method nystagmus appears after the passage into the ear of from 70 to 75 cubic centimetres of water; it is horizontal. Here, as in the rotation test, deviation of the limbs or swaying of the body when in the upright position or when walking, is in the opposite direction to the nystagmus, that is to say towards the irrigated ear.

Results in a pathological condition.—(1) *Exaggeration.*—The nystagmus is seen to appear sooner than normal, after fifteen or twenty seconds of irrigation by Barany's method, and after the passage of from 40 to 50 cubic centimetres of water by Brünings'. If we continue up to the normal doses of excitation the duration of the nystagmus is prolonged and intense reactionary phenomena take place—vertigo, falling down and vomiting—so that we have to be careful about starting them; if they occur we can afford relief by placing the head in the upright position.

(2) *Diminution.*—Nystagmus fails to appear after normal excitation; we must prolong irrigation to one minute and sometimes to 300 cubic centimetres of water. Labyrinthine excitability is inversely proportional to the duration of the irrigation or the quantity of water used.

If after this amount of time or water we cannot induce nystagmus, we must stop the irrigation and see if there is deviation of the trunk or limbs.

In cases of complete inability to produce nystagmus the reflex is abolished, the labyrinth is inexcitable.

(3) *Inversion*.—In certain very exceptional cases and in which symptoms of disturbance of equilibrium are marked, there is an inversion of the direction of the nystagmus and of the swaying; the nystagmus occurs in the direction of the ear being irrigated with the cold water.

Babinski's electrical test.—The following is the principle of Babinski's test: the poles of the circuit of a continuous current being applied in front of each ear in a normal subject, there is to be seen an inclination of the head and the trunk towards the positive pole when the current attains to a sufficient intensity. This inclination is due to excitation of the vestibular nerves, and the results of the test are different in the case of labyrinthine lesions.

Armamentarium.—The armamentarium is simple—a battery of 24 cells grouped for tension with a rheostat, so that the intensity of the current may be increased or diminished; a milliampère-meter for measuring; two flexibles; two ordinary electrodes covered with chamois leather, about the size of a shilling-piece, which are moistened with salt water at the time of the experiment.

Method of procedure.—The patient stands up, the feet together, the eyes shut; the observer standing in front of him applies the electrodes one in front of each tragus. The assistant increases the current very gradually, while reading the milliampère-meter; he stops when the observer gives the order after having

noted the inclination; he then gradually decreases the current down to zero.

Babinski has rendered the test more delicate by investigating the effect of electrification while the patient



FIG. 31.—Electro-diagnosis according to Babinski. The subject inclines normally to the positive pole.

is walking with the eyes shut instead of standing upright; it is only necessary to have long enough flexibles suspended from the ceiling. Deviation in walking denotes lateral inclination with a very feeble current. This modification is not indispensable; there is perhaps no real advantage in refining these

tests to an extreme degree, for only very decided differences distinguish the pathological condition from the normal.

Result in a case with normal labyrinths.—The patient inclines the head, then the trunk to the side of the positive pole when the intensity of the current reaches about 6 milliamperes; anything between 4 and 8 may be considered as normal. The impression produced is that of a feeble vertigo with a lateral impulse towards the positive pole, a tendency which it is impossible to resist. A stronger current produces nystagmus, but the test then becomes very painful.

Results in cases with diseased labyrinths.—The results of the experiment may be altered either by a diminution of the necessary electric intensity or, on the contrary, an increase, or, finally, a change in the direction of falling.

Lowering of the number of milliamperes necessary to produce swaying implies labyrinthine hyperexcitability. A current of one or two milliamperes may be sufficient in such a case. We may even see, in spite of the feeble intensity, a more violent impulse and marked vertiginous sensations, lasting sometimes a few minutes, whereas in normal subjects the vertigo ceases instantly. This hyperexcitability may exist alone or coincide with an anomaly in the direction of the falling.

Hypoexcitability or inexcitability is manifested by the necessity of raising the current to a notable extent above the normal amount or by the impossibility of producing the slightest vertigo by a current of 15 milliamperes.

This study of the anomalies of the direction of falling has seemed to us extremely interesting.

Babinski has laid down from the beginning that in the normal condition the subject inclines towards the positive pole and that with a pathological condition he falls towards the affected ear or towards the one most affected, whatever be the direction of the current. Later on he recognised that his formula was applicable to the majority but not to all pathological cases.

Our experience entirely confirms Babinski's published views; it seems to us that the direction of the falling in pathological cases may be explained and we shall formulate Babinski's law in the following way: In the normal state the subject inclines to the side of the positive pole; in the pathological state he falls to the side to which he has a tendency to incline spontaneously.

Thus, in a case with a unilateral labyrinthine lesion we shall see that the patient when walking with his eyes shut is inclined nearly always towards the affected side; this would explain how the galvanic inclination obeys Babinski's law and takes place almost constantly in the direction of the affected or the more affected ear. But our observations also show that the passage of the current nearly always produces a falling *backwards* when an investigation of walking and standing previous to the eyes being shut, revealed that the patient staggered while walking without inclining more to the right than to the left, and tended to fall *backwards* when in Romberg's position.

Does not this analysis explain singularly the physiological mechanism of Babinski's test? In the normal condition the passage of the current produces an inclination towards the positive pole.

In the pathological condition electrification exaggerates spontaneous inclination caused by the abnormal excitability of an affected labyrinth. If the labyrinth is destroyed there is no reaction.

Semeiological value of the test.—Babinski published his researches in electrification of the labyrinth long before Barany taught us the utilisation of provoked nystagmus. However, the two tests have not by any means had the same success among otologists. A serious theoretical objection has been raised against the value of Babinski's sign; as far as experience goes we believe that observers have been content with experiments carried out without confidence and in too small a number of cases.

Theoretically the objection has been that the electrification does not specially excite the labyrinth but the trunk of the nerve and even the brain, and that by reason of the impossibility of making allowance for each of these any conclusion was doubtful.

However, it can be proved that we have here a peripheral excitation and not a central one. What are, in fact, the combination and the order of the observed phenomena? The vertigo does not stand alone.

According to the intensity of the current there is observed, over and above the pricking sensation transmitted by the nerves of general sensation :—

- (1) A very decided salt taste ;
- (2) Lateral swaying with slight vertigo ;
- (3) Nystagmus with more marked vertigo ;
- (4) Finally, the passage of the current may produce a sensation of sound.

Thus it is not the nerve centres in general or any

particular forms of special sensibility that are excited, but precisely the three branches which traverse the petrous bone, namely, the corda tympani, the vestibular nerve and the cochlear nerve.

This peripheral excitation of a sensory nerve-branch expresses itself by a movement; is not this the definition of a reflex? Babinski's diagnosis by electricity makes use of a reflex which has all the objective value of reflexes, which can be measured in figures by the milliampère-meter, and which is the most convenient for use and the easiest to tolerate. It is impossible, in fact, to formulate an objection to its practice; the test takes little time and is not at all painful.

Does this mean that it should be used in preference to provoked nystagmus? By no means.

Rotation should still be used, for it represents the physiological excitation of the semi-circular canals, and the caloric test remains valuable as allowing of investigation of each ear separately and even, indeed, of each group of canals.

But the "Babinski" is so convenient and so clear that we should like it always to be the one to begin with in order to know in a few minutes whether the vestibular system works normally or not; in the same way Lombard's hearing-test tells us, before any other test is used, whether there is or is not serious organic labyrinthine deafness, either unilateral or bilateral.

We will show the great value of the "Babinski" by a résumé of a series of twelve cases which represent the entire experience of one of us during the last three weeks in which he directed his otological clinic.

Twelve patients were submitted to vestibular

electrisation from October 1 to October 20, 1916. Four were considered from all other points of view to have normal labyrinths; they inclined towards the positive pole with the use of an intensity of 6, 5, 4 and 6, 7 and 9 milliampères; as for the last one there was very slight chronic catarrhal median otitis; there was nothing to explain clinically the slight increase of resistance to the continuous current.

One injured man remained completely unaffected by 18 milliampères; he had a wound of the head from a projectile which had caused total unilateral labyrinthine deafness.

Four men suffering from concussion from explosion of a shell were hyperexcitable, and all presented disturbances in walking and standing upright after closing the eyes. In three of them the deviation did not take place in the direction of the positive pole but in that of the spontaneous tendency to fall; the same inclination was remarked in a fourth patient with Menière's disease (paroxysmal vertigo), who deviated to the right on walking, showing no nystagmus or any other vertiginous disturbance after the passage of 300 cubic centimetres of water at 25° C. (77° F.) into his right ear, and in whom 4 milliampères caused swaying to the right whatever the direction of the current.

Do not the examples furnished by these twelve non-selected patients corroborate our conclusions? We find three normal reactions in four subjects who did not show any vestibular disturbance, there only being a certain amount of hypoexcitability in the fourth; one case of complete inexcitability in an injured man whose labyrinth was destroyed; four cases of hyperexcitability in men suffering from

concussion and presenting marked disturbances of equilibrium, three of which inclined during the Babinski test in the direction of their spontaneous deviation; the same parallelism occurring in the case of Menière's disease.

CHAPTER V

RESULTS OF EXAMINATION AND PREPARATION OF THE REPORT

When he has finished his long, detailed and often difficult examination, the expert is in a position to deal with the different data of the problem submitted to him, to know the nature of the lesion, its cause, extent, prognosis and the medico-legal consequences of the disability resulting from it.

An accurate anatomical diagnosis is indispensable ; we must know whether we have before us a case of organic or functional deafness, of external, median, internal otitis or mixed lesions.

It will then be necessary to establish the relationship between the ascertained anatomical condition and the injury alleged as the cause. Traumatic lesions of other parts of the body do not, as a rule, call for discussion as to their origin ; the question of etiology presents for the aurist, on the contrary, the greatest difficulties, for those injured in war, as by accidents in time of peace, are apt to attribute an old-standing deafness to a recent traumatism, and we often have great difficulty in determining how far their statements are in accordance with the real facts.

The third object of the medical report consists in putting together the tests for measuring the degree

of deafness and determining the intensity of the vertiginous disturbances. This last estimation is necessarily vague; the measurement of the hearing can be fairly accurate; the special psychological conditions at the time of the medical examination for report (so different from this point of view to a clinical observation) oblige us to be reserved, and we content ourselves with an approximation; it is hardly possible for the aurist to write down that the acuteness of hearing is reduced to a third part or a quarter, as the oculist can do in regard to acuteness of vision; we prefer to state that the subject is totally or almost totally deaf, or has extreme, medium or slight dulness of hearing; we would willingly accept our colleague Molinié's proposition, namely, that aurists should agree to assign approximately the limits to similar degrees of deafness according to the auditory faculty for the human voice.¹

We are not obliged to give to the prognosis a precision which may lead to difficulties; we may consider as in all probability ameliorable all deafness accompanied by normal reflexes, and as having a reserved prognosis those cases where these same reflexes are abolished. Disturbances of equilibrium generally disappear at the end of a variable time.

The medico-legal consequences depend on the actual functional incapacity; they are established according to the regulation instructions relating to categorisation and to discharge. We must report with the greatest accuracy all organic changes; it is better to demand that the patient be kept under

¹ We might take as a basis Schwartz's classification, established according to the distance at which the conversational voice is perceived: below 1 metre; between 1 and 5 metres; between 5 and 10 metres; between 10 and 20 metres.

observation and submitted to the check of an expert examination in a neurological centre in the case of all purely functional disturbances which have resisted our treatment.

PREPARATION OF THE REPORT

The form for registering the measurement of the hearing-power drawn up by the Minister of War, to be filled up according to requirements, is sufficient for simple cases which do not call for discussion; it will always comprise a concise description of the normal or pathological anatomical condition, a diagnosis and precise conclusions.

A detailed report accompanies this form in all recommendations for discharge and in all those cases where there is a contradiction between the results of the examination and the statements of the injured man.

We propose to draw up this report according to the following plan :—

(1) **Former histories.**—To distinguish accurately between the narrative of the individual and the information furnished by his papers; to set one against the other should there be need for so doing.

(2) **Actual condition.**—**A. SYMPTOMS OF WHICH THE INJURED MAN COMPLAINS.**—To omit none of his statements; if necessary to transcribe them word for word.

B. OBJECTIVE EXAMINATION.—Normal or pathological condition. Lesions whether apparently of old standing or recent, spontaneous or traumatic.

C. FUNCTIONAL EXAMINATION.—(a) *Hearing.*—To refer to the acoumetric form; but to state

the reason for reserve with regard to apparent results, if called for, and then to narrate in all their details the different tests of good faith; this clear detailed statement should be written out in such a manner as to be comprehensible by non-specialist examiners.

(b) *Equilibrium*.—Reference to the case paper and report as to the genuineness and extent of the symptoms of which the patient complains.

(3) *Conclusions*.—*Total deafness, extreme deafness, etc.*, with or without equilibrial disturbances.

Caused or aggravated by : anatomical and accurate etiological diagnosis. If it is a wound, mention the wounding agent.

Susceptibility or not to relief or cure.

Actual functional incapacity valued at . . .

Recommendation. — Combatant or Auxiliary Service.

Discharge No. 1, with or without pension or gratuity.

Discharge No. 2.

Transference to another department for further examination.

N.B.—These conclusions are of two kinds : the first are entirely medical ; they relate to the existence and degree of the pathological disturbance, its causes and prognosis ; the second are medico-legal and refer to the consequences of the disability as to functional incapacity produced, to military fitness and to discharge.

The specialist confines himself strictly to the conclusions of the first group when he is acting simply as a doctor treating the patient, that is to say, when he fills in the medical history sheet and the clinical

notes which accompany the patient from hospital to hospital.

He should only mention the functional incapacity or express a recommendation with regard to discharge when he is asked to give his opinion on the subject. Any estimate and recommendation should never be known by the man interested ; they should be sent under sealed cover to the Committee on Medical Reports, for it is important that the medical examiner for the report, who is alone qualified to arrive at a decision, should be quite unprejudiced in doing so.¹

The circular (309 Ci/7) of November 5, 1916, states among other things : "The rôle of the physicians treating the cases, and notably of the specialists, in making up the papers consists in furnishing the most complete anatomical and clinical information, so as to permit the only legal authorities, namely the examiners and the discharging Boards, to give any opinion or to make any decision on the legal effects arising from the disabilities.

"The doctors treating the case must, therefore, abstain from all personal estimate of the amount of invalidity and from any suggestion as to the precise decision to be arrived at by the Invaliding Board, apart from the exceptional cases where the Boards or the examiners ask for their advice in consultation. This advice ought to be furnished under sealed cover and without the patient knowing the tenor of its contents. . . ."

This decision seemed too rigid for practical purposes, the medical reporters being unprepared to decide for themselves as to the different degrees of

¹ DUÇO and BLUM, *Guide du médecin dans les expertises médico-légales militaires* (Collection Horizon), p. 144.

invalidity in special affections, and a new circular (No. 413 Ci/7) of January 31, 1917, authorises the physician treating the soldier (1) to send *under sealed cover* to the principal medical officer of the discharge centre his personal estimate of the degree of invalidity and his suggestion as to the decision to be taken; or (2) to accompany the wounded man before the Board.

CHAPTER VI

LESIONS OF THE EAR AND MILITARY FITNESS

The circular of April 1, 1916, has modified the old ordinances concerning the fitness for military service of the subjects of aural lesions.

External ear.—"Congenital or acquired atresia of one or both external auditory meatuses or malformations of the auricle should not be taken into consideration unless they cause deterioration of the auditory acuteness.

"Acute or chronic inflammations of the external ear (auricle, meatus) are never a reason for exemption; they are compatible with combatant service."

Middle ear.—"Chronic otorrhœa with suppuration and a destructive lesion of the walls and contents of the tympanic cavity or of its adjacent cavities (osteitis, cholesteatoma) calls for postponement of service or temporary discharge.

"Subjects with these lesions will not be exempted or definitely discharged until all the means of treatment have been exhausted, including curetting the tympanic cavity or even performance of the petromastoid operation.

"Cicatrised perforations, without osteitis or

Application of the Circular No. 159 CI/7 of July 15, 1916.

OTO-RHINO-LARYNGOLOGICAL CENTRE OF THE

REGION

OTO - RHINO - LARYNGOLOGICAL FORM

of the man named (Name, Christian) _____
names, age

(rank and regiment) _____

Treated in the _____ centre of _____ from _____ to _____

Diagnosis on discharge: _____

DESCRIPTION OF THE OTOLOGICAL LESIONS



L. T.

R. T.

Examination of nose: _____

Examination of naso-pharynx: _____

Examination of larynx: _____

Precautions to be taken (if called for) _____

Fitness for service _____

Principal of the Centre.

the 19

cholesteatoma, with intermittent mucoid or mucopurulent discharge, are compatible with combatant service. They only call for classification in the auxiliary service when the auditory acuteness is below the limits fixed for combatant service."

[The purpose of the legislator is thus quite clear ; he has distinguished between two kinds of otorrhœa ; the first group includes cases of osteitis and cholesteatoma ; we would add perforations of Shrapnell's membrane ; these are cases of otitis liable to complications ; they are dangerous to life ; they must be dealt with surgically if we wish to cure them quickly and sufficiently to be of use ; in the contrary case they must be rigorously cleared out of the Army. The second group comprises the immense legion of ear discharges with large perforations without osteitis or retention, and more or less profuse according to the hygienic care bestowed upon them. The patients would be discharged in time of peace ; they should not, however, be prevented from taking part in the campaign ; above all, they should not encumber our hospitals and pass the greater part of their time in them ; the aurist should not expect ideal absolute drying-up of the discharge ; he should content himself with curetting a blocked-up naso-pharynx, removing polypi and cleansing a profuse ear discharge, and then send the patient to his regiment with the statement : *fit for combatant service*. The oto-rhinolaryngological form figured above should be inserted in the soldier's documents for the information of the regimental doctor.]

"Sub-acute or chronic catarrhal otitis with intermittent deafness (tubal catarrh) is compatible with combatant service.

“Cicatricial otitis secondary to suppurative otitis or to unilateral or bilateral surgical operation is compatible with combatant service or auxiliary service according to the degree of hearing-power, which alone should be taken into consideration.”

Internal ear.—“The same rules apply to suppurative lesions of the internal ear as given for suppuration of the middle ear. Unilateral or bilateral non-suppurative affections of the internal ear shown chiefly by subjective symptoms (vertigo, tinnitus, deafness) must not be considered in connection with the proposals concerned except as regards the resulting deafness and the lesions of the vestibular apparatus and nervous system which can be clinically detected.”

Acuteness of hearing and deafness. Labyrinthine disturbances.—“The required amounts of auditory acuteness are as follows :—

“(a) *Combatant Service.*—The whispered voice with residual air must be heard at 50 centimetres.

“Loud voice between 4 and 5 metres.

“The word of command at 10 metres.

“(b) *Auxiliary Service.*—A quarter of the auditory acuteness required for combatant service, say, whispered voice about 12 centimetres; loud voice, 1 metre 25; word of command, 2 metres 50.

“(c) Auditory acuteness below this calls for exemption or discharge.”

[N.B.—Deafness for the whispered voice is difficult to check. Suspected individuals should be classified according to the hearing for loud voice alone (the authors.)]

“The deafness may come on alone or accompanied by tinnitus and vertigo.

“When the deafness is accompanied by tinnitus

and vertigo the latter symptoms should only be taken into account when they can be confirmed by neurological examination of the labyrinthine apparatus."

[Vestibular examination, Romberg's, Babinski-Weil's and Barany's tests ; test for voltaic vertigo.]

"(a) Total bilateral deafness calls for exemption or discharge.

"(b) Total unilateral deafness calls for classification in the auxiliary service, even when the auditory acuteness of the other ear is normal.

"(c) Partial unilateral deafness is compatible with combatant service.

"(d) Partial bilateral deafness permits of classification in the combatant service or in the auxiliary service according to the degree of acuteness of hearing ascertained."

FITNESS FOR AVIATION

(Circular of April 1, 1916.)

"Normal auditory acuteness with soundness of the middle and internal ears and especially of the equilibrial apparatus."

[There is no need to insist on the necessity of eliminating all men with affections of the tubotympanic apparatus, tubal catarrh, or atrophy of the tympanic membrane, in view of the enormous variations of barometrical pressure to which aviators are submitted.

The tests with the watch, loud and whispered voice will suffice for recognising a normal auditory acuteness.

Romberg's and Babinski-Weil's tests do not require special instruments. In the absence of a

chair or a swing, vertigo, or rather post-rotatory deviation, can be investigated by making the patient turn round on himself. An ear-syringe and water at 27°C . (80.6°F .) are sufficient to provoke caloric nystagmus, but these two last tests do not appear to us to be indispensable if all the preceding investigations have shown the ears to be normal, while if they had been shown to be otherwise, a negative conclusion would have been already arrived at.]

CHAPTER VII

DISCHARGE No. 1.

Pensions.—Gratuities.—Retiring pensions for wounds and injuries arising from military service are due when these wounds and injuries are *incurable*, and from the point of view of their severity, they come under one or other of the six categories established by the law of 1831.

This last condition applies only to non-commissioned officers and men; for officers it is enough that the infirmity renders them unable to remain on the active list and deprives them of the possibility of remaining thereon in the future.

The law of 1831 classified deafness under two categories :—

(1) Complete deafness of both sides resulting from injury or disease contracted during service is put down as No. 19 of the 5th class. It gives a right to a pension of 600 francs for a soldier of the second class.

(2) Very marked diminution of hearing on both sides, or complete deafness of one side with facial paralysis or destruction of the external auditory apparatus, resulting from injury or disease contracted during service comes under No. 50 of the 6th class.

It gives the right to a pension of 600 francs for a soldier of the second class.

The law of 1831 is in force so far as it has not been repealed, consequently the expert who finds himself confronted by an *incurable* disability coming under one of the classes enumerated by that law is obliged to adjudge the retiring pension in accordance with it.

Does this mean that we must adjudicate in the same way for all cases of bilateral deafness and unilateral deafness with facial paralysis? Not at all. To act thus would be to settle the future very imprudently, for a retiring pension is always awarded permanently.

The pension is reserved for *incurable* cases, and experience has taught us how careful we must be in giving a prognosis of incurability in a case of deafness or facial paralysis.

The question of incurability must in most cases be set aside and the injured man recommended not for a pension but for a gratuity which may be renewed or modified. The scale of these gratuities, much more elastic than that of the law of 1881, allows consideration of a much larger number of cases and more equitable compensation to the injured men.

Disabilities give no right to a gratuity when the disablement is valued at less than 10 per cent. It is worth while, however, to make note of an incapacity even of only 5, 7, or 8 per cent., because the amount of damage incurred is thus recognised and the rights of the injured man to future compensation in case of aggravation of the condition are maintained.

The indications given below have been furnished

to the expert examiners for the forming of their conclusions. They are not by any means of an authoritative character and are sufficiently elastic to permit of estimating each case taken individually. (*Circular of March 24, 1915.*)

“Ears.—Loss of cartilage.—The cartilage not being necessary for hearing, its loss presents chiefly an æsthetic inconvenience, detriment from which, as already seen, is not admitted by the law of 1898.

“The Vienna scheme admits, however 8 per cent.

Röpke 10 to 15 ..

“The ear, like the eye, being capable of compensating for the opposite one, unilateral lesions must be carefully distinguished from bilateral ones. It is expedient also to separate dulness of hearing from deafness.

A. Unilateral Lesions.

Dulness of hearing on one side	10 per cent.
Deafness of one ear without noises or vertigo	10 to 15 ..
Deafness of one ear with noises and vertigo	30 ..

“*Aural suppuration.*—This is a question of disease (osseous caries) subject to serious complications, and not merely a disability; it calls for treatment; the hearing is nearly always involved, sometimes irremediably; the incapacity resulting from it is variable and may fluctuate between 20 and 50 per cent.

B. Bilateral Lesions.

Dulness of both ears	10 to 15 per cent.
Dulness of one ear and deaf- ness of the other	25 to 30 „
Bilateral deafness	50 „

“ *Vertigo*.—Vertigo is as difficult to prove as persistent pain; it is, however, a source of great inconvenience when it really exists.

- “ President Duchauffour, in doubtful cases, estimates an incapacity of 0 to 30 per cent.
- “ And in certain well-proved cases an incapacity of 50 to 60 „

These are average figures established according to the law dealing with workmen's accidents; they may also serve as indications for the application of the law of 1898; but the examiner for the medical report must remember that military law does not recognise the injured man's occupation, whereas the civil law, on the contrary, has for its object the reparation of the loss incurred and takes the man's occupation into account; the figures above mentioned will, therefore, err on the side of excess or insufficiency, according to the case, if judged by the standard adopted in civil practice.

Apart from this question of compensation, the medico-legal examinations for reports, whether military or civil, are quite similar; we have described the various considerations as completely as we have been able, hoping that our labour will serve not only for the present moment but also for the day when we shall all again have taken up our ordinary course of work.

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MALARIA IN MACEDONIA: Clinical and Hæmatological Features. Principles of Treatment. By P. Armand-Delille, P. Abrami, G. Paiseau and Henri Lemaire. Preface by Professor Lavern, Membre de l'Institut. Edited by Sir Ronald Ross, K.C.B., F.R.S., LL.D., D.Sc., Lieut.-Col. R.A.M.C. With illustrations and a coloured plate.

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